ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XLV. No. 10.

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THE LONGEST STONE ARCH BRIDGE in the world is under construction at Luxembourg, over the valley of Petruffe. According to meager published accounts this arch will have a span of 277 ft. and a rise of 102 ft. The total width of the available roadway is 52 ft., and this width is divided into two parts by a space 19 ft. wide, covered by slabs of armored concrete and carrying the footways. In comparison, the longest existing stone arch is that over Cabin John Creek, on the aqueduct near Washington, D. C.; this has a span of 220 ft. and a rise of 57½ ft., and is 101 ft. above the water level in the creek. The Jaremcze stone arch, over the River Pruth in Eastern Austria, has a span of 213 ft. and a rise of 59 ft. The Grosvenor arch bridge over the River Dee, near Chester, England, has a span of 200 ft.

THE RIVER AND HARBOR BILL, carrying an appropriation of nearly $60,000,000, failed to pass Congress before its adjournment on March 4. The failure to bring the bill to a vote was due to filibustering tactics on the part of Senators Wellington of Maryland, and Clark of Montana, who held the floor of the Senate with speeches in condemnation of the extravagance of the bill until the time for adjournment and expiration of the present Congress at 12 o'clock noon March 4 came around and the measure was killed.

THE WAR APPROPRIATIONS of the United States now exceed those of any nation except England. In a speech in Congress on Feb. 12, Hon. Geo. B. McLellan showed that the total appropriations for war purposes as then pending at the present session of Congress amounted to $233,102,000. This does not include the cost of past wars in the shape of pensions, etc. With this included, the total war expenditure of the United States amounts to $386,818,000 or $5.06 per capita of population. Germany's war budget is $188,547,000, France's is $190,197,000, and Russia's is $148,060,000.

AN AERIAL TORPEDO has been invented by Major W. T. Unge of the Swedish army and trials are to be made of it by the Swedish government. The torpedo propels itself through the air by the reaction of gas produced in its interior by a slow-burning powder. The torpedoes thus far made have a range of 4,000 to 5,000 meters and carry five or six pounds of explosive which is set off when the torpedo strikes. The torpedo is discharged from a light tube, and as there is no shock attending the discharge almost any explosive can be carried.

ELECTRICITY AS A WEAPON in a railway war was tried in Edgewater, N. J., last week. The borough authorities sent a force of men to tear up a track laid a few days previously by the New Jersey & Hudson River R. R. Co. across the River Road, near the Fort Lee ferry house. The borough counsel declared the track to be illegally laid; but when the street commissioner's force started to rip up the rails a lineman employed by the railway company threw a coil of wire across the overhead trolley wire and connected the ends with the rails in dispute. The result was that four laborers who were sawing at the rails were hurled several feet by the electric current, and the borough men were forced to stop work. The lineman was finally arrested and after the wires were disconnected the rail-lifting was resumed, and the track was removed after some other demonstrations by the railway men.

A REMARKABLE BOILER EXPLOSION which occurred at Los Angeles, Cal., Dec. 5, 1900, is reported in detail by our contemporary "Power." A battery of water-tube boilers was fired with crude petroleum, and about 11 hours before the explosion occurred the engine room force discovered that the fuel oil was being pumped into the boiler, and some 10 ins. depth showed in the gage-glass. As the boilers were furnishing steam for an electric street railway line it was decided to keep on running and take the risk of trouble. The trouble came, however, in the shape of an explosion which completely demolished the boiler and scattered some of its fragments a quarter of a mile away. The boiler house was demolished, the fireman was killed and the engineer seriously injured.

THE BERLINER TELEPHONE TRANSMITTER patent was declared invalid on Feb. 27 by Judge Brown of the United States Circuit Court for the district of Massachusetts. The decision declares that Berliner was antedated by both Bell and Edison in the invention of a telephone transmitter. The decision, as handed down by Judge Brown, discusses in a very lucid manner the points at issue.

PLANS FOR A HIGH-SPEED ELECTRIC RAILWAY have been laid before the Emperor of Germany by Herr Rathenav, Manager of the Allgemeine Elektricitäts Gesellschaft. No actual work has yet been done, but it is proposed to build a military line from Berlin to Zossen upon which a speed of 125 to 150 miles per hour can be reached. For this line a train will be built by each of the two great German electrical companies, the Allgemeine Elektricitäts Gesellschaft and Messrs. Siemens & Halske, who, together with some of the German industrial banks, have formed the Studiengesellschaft für Elektrische Schnellbahnen, which is making active preparations for carrying out the project.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Southern Ry. at Lenoir City, Tenn., on March 2. Two freight trains collided head-on, resulting in the death of four trainmen and the fatel injury of two others. The accident is said to have been due to a misunderstanding of orders.

WORK ON THE JUNGFRAU RY. is reported to be again in progress, although its cessation during the tourist season last summer led to statements that the scheme was to be abandoned. Reports early in the year stated that kilometer 3.63 was expected to be reached by the end of January.

A NEW DESIGN OF SPLIT SWITCH has recently been placed on the market by the Weir Frog Co., of Cincinnati, O., in which the switch rail is re-enforced on both sides with strips of wrought iron extending from the point back to the angle bars with ¾-in. rivets passing through both re-enforcing pieces and the web of the switch rail. With this re-enforcement, it is claimed that even if the switch rail should break, it will be held in line. A novel plan of adjusting the head rods has also been adopted. The switch lugs are drilled with a row of holes spaced 1¼ ins. c. to c., while the switch rods are drilled with holes 1⅛ ins. c. to c. By changing the bolt from one hole to the next an adjustment of ⅛-in. is made, and when once bolted the length is fixed.

A GOOD-ROADS SPECIAL TRAIN is being sent out over the Illinois Central R. R. by the National Good Roads Association. The train is made up of nine cars, including a commissary car and enough flat cars to carry modern road-making machinery. This train is to spend three months in the trip from Chicago to New Orleans, and at twenty or more points on this line expert roadmen will build about one mile of road. Advance agents will arrange with the farmers to provide the materials and to witness the methods of modern road construction.

THE ELECTRIC VEHICLE BOOM, which aroused so much public interest in 1899, seems to have suffered thorough collapse. The Illinois Electric Vehicle Co., one of the concerns of which the Electric Vehicle Co. acted as a parent, is reported as about to be wound up. This interesting concern was originally incorporated with a capitalization of $25,000,000. This was later reduced to $2,500,000. The company has been operating electric cabs in Chicago, but it is now admitted that the heavy cost of repairs make it impossible to continue operations.

THE SPOIL BANKS of the Chicago Drainage Canal, comprising some 22,000,000 cu. yds. of limestone and 10,000,000 cu. yds. of earth, mostly clay,are to be offered for sale. At a recent meeting of the Board of Trustees of the Sanitary District it was voted to ask for bids for the purchase of the material. It is expected that the stone will be crushed and used for concrete and road making, etc., and that much of the clay will prove suitable for brick making.

THE CHICAGO DRAINAGE CANAL water power development is provided for in a bill which has been introduced into the Illinois State Legislature. This bill empowers the Board of Trustees to assess an additional tax of ⅛ of 1%, the proceeds of which are to be used in developing the water power of the Drainage Canal at Lockport, Ill. It is estimated that the proceeds of the tax will amount to about $2,500,000.

A SANITARY SEWERAGE SYSTEM for Baltimore, Md., is again under discussion, but nothing very definite has been done to secure it. Aside from the expense involved for the collecting system, there has been much opposition to the proposal to discharge the sewage into the harbor, partly on account of alleged damage to the oyster industry.

THE INCREASE OF WATER CONSUMPTION in the Metropolitan water district, including Boston and other cities and towns, has been 54% in the ten years 1890 to 1900. The actual figures are 73.3 gallons per capita per day in 1890 and 112.8 gallons in 1900. For the year 1900 the consumption was 6.4%, or 5.5 gallons per capita, more than for 1899. These figures are given in the last report of the Metropolitan Water Board, just submitted to the legislature.

ELECTROLYSIS IN LONDON, ENGLAND, is attracting attention, according to a letter from the English correspondent of the "American Gas Light Journal." It is said that the mains of the Lambeth Water Co. and the South Metropolitan Gas Co. have been affected by currents from an electric railway between the city and Clapham. It is contended that this electrolytical action shows the insufficiency of the regulations adopted by the Board of Trade after its hearing on electrolysis in 1893.

AN INTERNATIONAL ENGINEERING CONGRESS is to be held in connection with the Glasgow exhibition, described in our last issue. The Mechanical Section of the Congress will be in charge of the Institution of Mechanical Engineers of Great Britain and the sessions will be held during the first week in September.

THE PREVAILING RATE OF WAGES LAW, affecting municipalities in New York state, has been declared unconstitutional by the Court of Appeals, in so far as it relates to contractors for city work. By implication, it is unconstitutional throughout. The law provided that all employees on municipal work must be paid the prevailing rate of wages for that class of work, which has been interpreted as meaning the scale fixed by the trade unions. If the opinion should be extended to cover the direct employees of the city it would save the city of New York many million dollars on account of claims for back wages alone.

A GREAT INCREASE IN GOLD PRODUCTION is predicted by Prof. N. S. Shaler, of Harvard University, in a recent public address. The grounds for the prediction are the modern improvements in mining machinery, which make possible the working of vast deposits of low-grade ore. According to press reports, Prof. Shaler stated that there are 4,000 to 6,000 sq. miles of alluvial plains in America which can be made to yield enormous quanities of gold, and he predicted that the total quantity of gold in existence would be quadrupled in the next 40 years. So great a production would evidently largely reduce the value of gold in comparison with silver, and Prof. Shaler is even said to have prophesied that silver would yet replace gold as a measure of value, on account of its greater stability in price.

A 125-MILE ELECTRIC TRANSMISSION LINE is being built from Colgate, on the Yuba River, to Vallejo, in California. Power will be sold to the electric light company in Vallejo and to the Transit Co., of Oakland. At the Carquinez Straits high towers have been built which will support cables carrying the electric conductors over the straits.

THE MINERAL PRODUCTS of the Ural Mountains are reported upon by U. S. Consul-General W. R. Halloway, of St. Petersburg. The smelting of pig iron was commenced in the Urals in 1891, and the output for 1900 was 797,000 tons. Of the 107 works in operation at that date 65 produced pig iron, 39 merchant iron, three rails, seven machinery and one railway cars. Coal has been mined for 25 years in most primitive fashion; the five mines on the Eastern slope produce 325,000 tons, and the three on the Western slope 9,700 tons annually. The coal is poor in quality and is used for coking. The three copper plants in operation produced 230,000 poods in the past two years, or about 4,140 tons. The Ural platinum mines furnish 96% of the world's supply of that mineral, and they produced 11,989 lbs. in 1900. The gold-producing beds have been largely exhausted, and during 1900 only 19,970 lbs. were taken from the placer beds. The Consul-General says that Russia is anxious to develop its mining industries in the Ural and elsewhere and is now proposing to modify its present exacting mining laws so as to encourage the organization of foreign companies and the enlistment of foreign capital in these enterprises.

MICROSTRUCTURE OF THE STEEL IN A DEFECTIVE CIRCULAR SAW.

By James A. Aupperle.*

The writer recently received the fragments of a large circular saw, which was said to have broken into many pieces after using but a short time, and it was desired to determine if possible the cause of the failure.

Six pieces were cut from different parts of the saw and borings were taken from each and analyzed with the following average results:

Carbon, 1.090; manganese, 0.530; silicon, 0.140; sulphur, 0.019; phosphorus, 0.011.

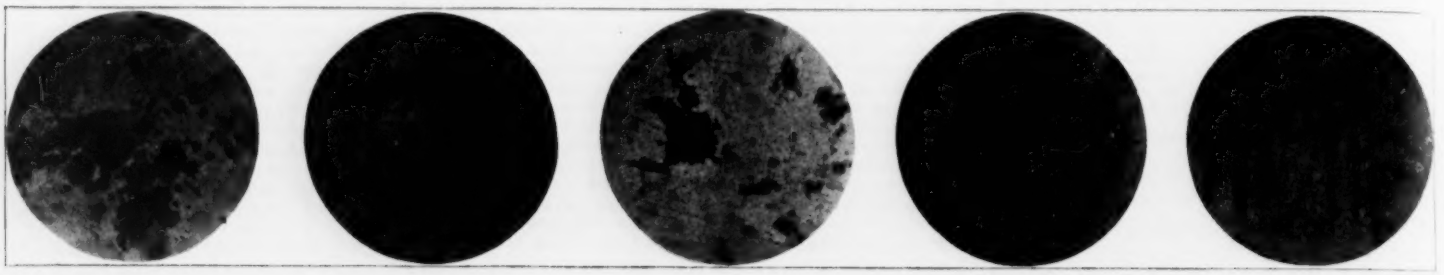
It is a well known fact that high carbon crucible steel is very sensitive to the elements usually found in steel, when they exceed certain limits. This analysis would represent a fair grade of circular saw steel were it not for the fact that the percentage of manganese is about twice as high as it should be, and would have been sufficient reason for the saw manufacturer to reject the steel, had he known its analysis. The high percentage of manganese in connection with high carbon would have a tendency to make the steel too hard and brittle.

Pieces about 1 sq. in. in area were next cut from the original samples and were microscopically examined. The samples were first gaged in order afterward to determine the percentage of the reduction of thickness and were then filed, polished on a No. 46 emery wheel, then by hand on wet emery, then with finest carborundum and finally finished on jeweler's rouge. When the specimens were entirely free from scratches, they were ready for the microscopical examination.

Upon examining the unetched samples with low magnifying power, a spongy or honeycombed structure was revealed, which in all probability was caused by the steel when in the molten condition being too wild when poured. This honeycombed structure reduced the strength of the steel, and, with the high percentage of manganese, was the cause of the saw breaking in so many pieces. Had the steel been sound the saw would not have broken so badly, even had it struck some hard substance while in use. The writer has known instances where circular wood saws cut into iron and steel and were but slightly damaged.

The accompanying cuts are reproduced from micro-photographs of the samples. Nos. 1, 2, 3 and 4 are unetched samples, each magnified 68 diameters. No. 1 is from a sample with 5% of its thickness removed, No. 2 had 10% removed and Nos. 3 and 4 were taken after the sample had been reduced one-fourth and one-half of its original thickness respectively. It will be seen that the steel has the most open structure near the surface and at the middle of the plate is comparatively solid. Micro-photograph No. 5 shows the polished edge of the steel etched with iodine and magnified 125 diameters. It shows a cross section of the defects and also indicates the direction in which the steel was rolled.

*Care E. C. Atkins & Co., Indianapolis, Ind.



No. 1. No. 2. No. 3. No. 4. No. 5.

MICROPHOTOGRAPHS OF STEEL FROM A DEFECTIVE CIRCULAR SAW.

(Nos. 1 to 4, unetched samples at different points in the thickness of the saw, magnified 68 diameters. No. 5, etched sample from edge, magnified 125 diameters.)

MUNICIPAL IMPROVEMENTS AT CHATTANOOGA, TENN.

The greater part of the municipal improvements of Chattanooga have been carried out under the direction of a board of public works, with Mr. Robert Hooke as city engineer and engineer to the board. The board was created in 1890, by a special act of the legislature, to have charge of the expenditure of $500,000 of paving bonds, an unexpended balance of $125,000 of an original issue of $200,000 sewer bonds and any money subsequently raised for constructing or maintaining streets and sewers. Mr. Hooke has been continued as city engineer from his appointment early in 1890 to the present time. We are indebted to him for courtesies extended to a member of our editorial staff during a visit to Chattanooga in December last.

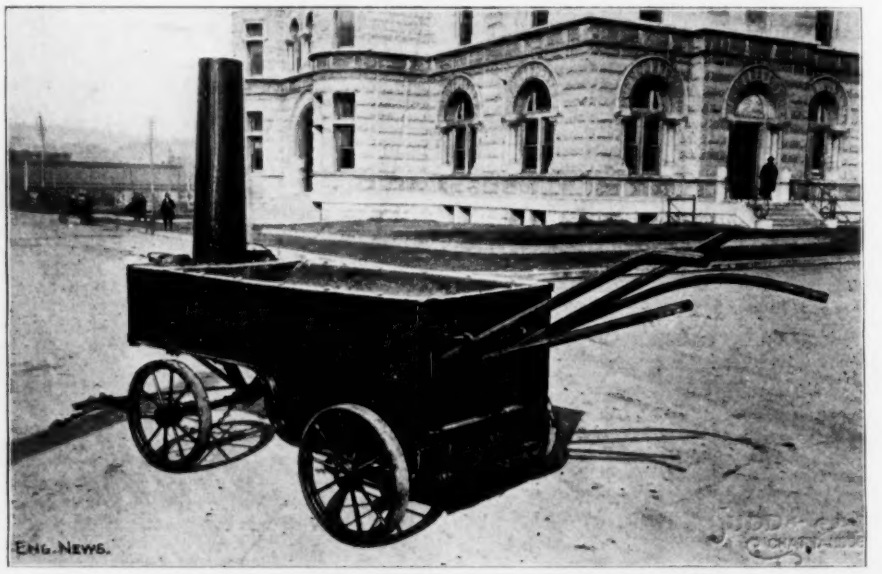
The board has been much hampered in developing its public works by a constitutional provision which the State Supreme Court has interpreted as prohibiting assessments for benefits against abutting property. This provision is to the effect that all real estate must be assessed at its actual cash value, which the court holds precludes any assessments on the front-foot basis, and which seems to be accepted as barring out assessments for benefits on any other plan.

As to sidewalks, the city is in a little better position than in the matter of street work and sewers, since the Supreme Court has held that property-owners who fail to provide or maintain a proper sidewalk are liable to action for a nuisance. Under this ruling, the board of public works orders sidewalks put in or repaired, and on failure of the owner to comply with the order the board does the work and collects the cost from the property-owner, but he is personally liable, only; or in other words, no lien on the property can be maintained. This is a cumbersome method, at best, of securing good sidewalks.

Legislative authority must be obtained for all bond issues for public improvements, so altogether it will be seen that the city has little freedom in the making of betterments. Nevertheless, it claims to be one of the best paved and sewered cities in Tennessee and the only one having asphalt pavements.

The sewerage system of Chattanooga dates from 1880, when the city engaged the late E. S. C[illegible]brough, then city engineer of Chicago, "as [illegible]sulting engineer on the work of designing th[illegible]posed sewers" (Report Board Public Works, [illegible]. This action was prompted by the yellow [illegible] epidemic of 1878. Mr. Chesbrough's designs [illegible] based on a rainfall of 1 in. per hour, the s[illegible] being on the combined plan. Up to April 1, [illegible] when the street and sewer work of the city [illegible] placed under the control of the board of p[illegible] works, there had been built 13.03 miles of [illegible] and 7.37 miles of brick sewers, making a to[illegible] of 20.4 miles. The largest sewer in the city, th[illegible] Broad St., designed and partly built in 188[illegible] egg-shaped, 40 × 60 ins. at the upper end and [illegible] 75 ins. at the lower end.

The Broad St. sewer discharges into the Ten[illegible]see River, near the old and once busy wharf of [illegible] Tennessee River Transportation Co. In 1891 [illegible] 1892, this company made several complaints of nuisance from the sewer, and that the sand, gravel and loose stones brought down by it were forming a bar which interfered with navigation. The company threatened suits if a change was not made. Accordingly, Mr. Hooke inserted a trap in the bottom of the sewer, at a point 100 ft. from its mouth, and laid a 20-in. cast-iron pipe, 230 ft. long, extending down-stream at an angle of 25° with the main outlet. This pipe has a grade of 4 ft. per 100. Its connection with the main sewer is shown by the accompanying section. The 16-in. pipe, also of cast iron, shown in the section, together with the upper manhole, was laid to divert the sewage, while the large manhole, or diverting chamber, was being constructed. In Mr. Hooke's report for 1890-3 he says:



PORTABLE ASPHALT REPAIR PLANT USED AT CHATTANOOGA, TENN.
Robert Hooke, City Engineer.

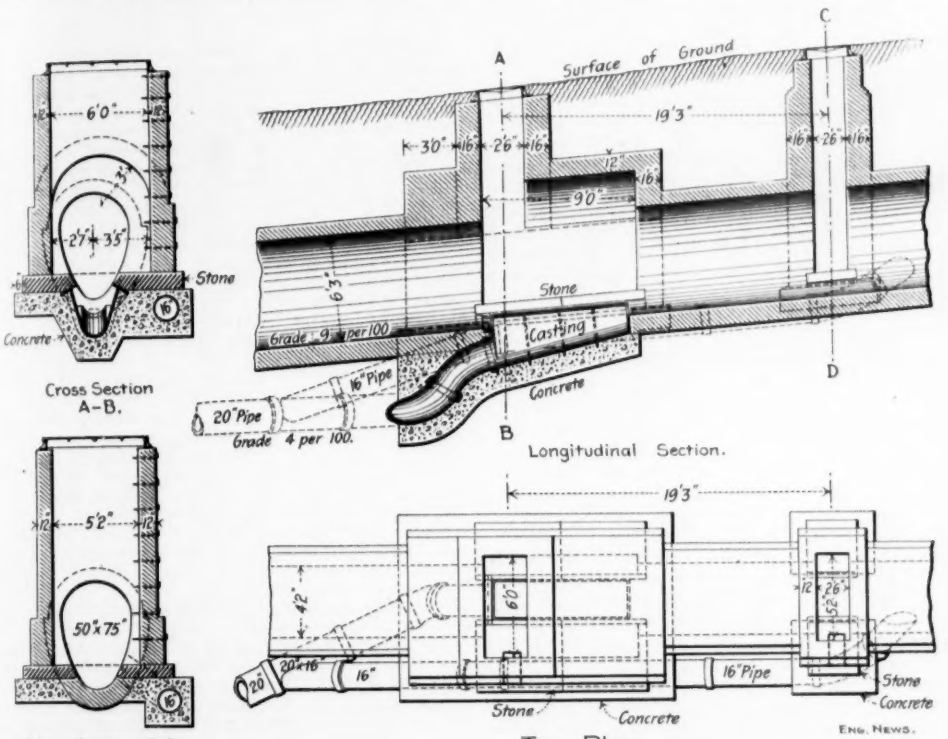
> With reference to the working of the sewage diverter, it may be said that whenever the river is at a stage of 9 ft. or under the sewage will be diverted into the iron pipe, which has capacity enough to carry a moderate rainfall in addition to the sewage. The velocity, nearly 20 ft. a second, with which the water enters the pipe when rain is falling, is sufficient to carry through all sand, gravel or other solid matter that may enter it.

In case of a stoppage, the sewage may be turned

the 16-in. pipe, at the upper manhole. The diverter, as it is called, has given satisfaction.

Most of the sewers of Chattanooga are on the combined system, but there are some sewers to which only roof water is admitted. In 1893, seven sewerage districts had been added to the one laid out by Mr. Chesbrough in 1880, with six outlets. Four of the outlets were into the Tennessee River, one directly into Chattanooga Creek, and one indirectly into the creek through a temporary outlet 1,400 ft. distant. The latter was extended to the Creek in 1899. There are no towns on the river for a long way below Chattanooga. Up to 1893, all sewers requiring a capacity equal to an 18-in. pipe had been built of brick, and all of less capacity of vitrified clay pipe. To the same date, 8-in. laterals had been used in residence streets where the sewers carried house wastes and roof water, only, and where the sewers were not more than 400 ft. in length. Under the same conditions, surface only 2 ins. in depth. With the exception of three blocks under a ten-year guarantee, which expires next spring, all the asphalt was laid under five-year guarantees, and consequently all the guarantees, but one, have expired.

The early Market St. asphalt was renewed in 1900 by the Barber Asphalt Co. A layer of 2½ ins. was placed on the old asphalt, after the latter had been heated and corrugated. The contract price was $1 per sq. yd., with a ten-year guarantee. The board of public works had awarded a contract for repaving this section with brick, and work had been started between the railway tracks, when the contract was declared illegal. On readvertisement, the asphalt people seized the opportunity to prevent the substitution of brick for asphalt, by making the favorable terms mentioned, which, the company claims, are less than cost. The brick paving already started necessitated the raising of the grade of the asphalt, which was accomplished by placing the new material on the old, as already stated.



DETAILS OF SEWAGE DIVERTER OR INTERCEPTOR, CHATTANOOGA, TENN.
Robert Hooke, City Engineer.

but with the admission of surface water, the diameters had not been less than 10 ins., wherever the sewers had been built after plans by Mr. Hooke.

The mileage of sewers at the close of 1900 was about 36, of which 9 miles were of brick and 27 miles of pipe.

Progress in street improvements in Chattanooga, as well as the present status of improved streets, is shown by the following figures of mileages of the different classes of pavements when the board of public works assumed charge in 1890, some three years later, and at the present time:

	April 1, 1890.	Mch. 1, 1893.	Dec. 31, 1900.
Sheet asphalt	0.92	2.45	2.45
Granite block	0.28	2.08	2.08
Brick	0.14	3.98	3.98
Asphalt block	....	1.03	1.03
Telford	....	0.51	.51
Macadam	1.29	2.95	2.95
Gravel (largely chert)	....	....	6.34
Total	2.63	13.00	19.34

It will be noticed that except for the gravel and chert, no permanent street improvements have been added since early in 1893, when, presumably, the proceeds of the paving bonds of 1890 were exhausted. All the pavements proper are laid on 6 ins. of concrete.

The first asphalt was laid on Market St., from Fourth to Ninth, by the Warren-Scharf Asphalt Co., having been completed in July, 1888. It had a wearing surface of 2½ ins. of asphalt, laid on 6 ins. of cement concrete, the standard for all the asphalt laid, except one stretch having a wearing surface only 2 ins. in depth. With the exception of three blocks under a ten-year guarantee, which expires next spring, all the asphalt was laid under five-year guarantees, and consequently all the guarantees, but one, have expired.

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During the year 1900, Mr. Hooke devised and put in service a portable asphalt repairing plant, consisting of a small heater, mounted on four wheels and easily drawn, on the level, by two men. Prior to this year, all repairs on streets where the guarantee had expired were made by the Warren-Scharf Asphalt Co., which sent men to Chattanooga and opened up its old asphalt plant there. Under such conditions, repairs could be made only about once a year.

The asphalt heater is about 3½ × 7 ft. in plan and some 4 ft. high. On top there is a melting pan about 3 × 5 ft., and a few inches in depth, and beneath this is a fire-box, and still further down there is an ash-pit. On each side of the smoke-stack there is a hole for placing a small pail in which liquid asphalt is heated for painting seams. Thus far, waste asphalt has been used for repairs. A little water is placed in the melting pan and enough asphalt thrown in to repair 3 sq. yds. of pavement. Then 3 qts. of residuum oil are added. When the mixture is ready it is applied to the surface to be repaired, which has been cut out in advance. The tools are heated by placing them in the fire-box, as shown by the accompanying view.

Brick pavements on 8¾ to 6% and lesser grades have been down eight years with good results, the amount on the steepest grades being quite limited. Rounded corners and narrow brick were used on the steep grades.

No ordinary macadam has been laid for eight years, chert being cheaper and more satisfactory. A blue limestone was used for the macadam and some has been down eight years without the addition of new material. It still has a good surface, but Mr. Hooke said it had worn down 3 or 4 ins. It was flanked with brick gutters.

The chert used for street improvements is shipped in some 40 miles by rail, costing, this year, 65 cts. per cu. yd. on the cars in the city and 25 cts. for cartage, or 90 cts. in all. The chert is laid on 6 ins. of compressed slag, the chert, after rolling, being 4 ins. in depth. It is now proposed to use, on residence streets, 4 ins. of slag and 2 ins. of chert, it having been found that fine slag gives a good road surface after the chert wears down to it, the chert, of course, working into the spaces between the slag.

On the better classes of streets, where chert is used, 20-in. brick gutters are placed, with 4 ins. of granite blocks between the brick and the chert. The brick are laid on edge, parallel to the curb, on 1 in. of sand, resting, in turn, on 5 ins. of gravel. Furnace slag and fine chert is now being substituted for the gravel. The row of granite blocks is ¾-in. above the brick, but flush with the chert. The chert streets are not cleaned, but the rain washes the dirt from them into the brick gutters and the latter are cleaned occasionally.

The chert is laid close to street railway tracks. The only objection to this practice is on steep grades, where there is a tendency for the water to cut out the chert on the inside of the rail along the bracket-like groove of the Johnson rail section. This can be obviated by laying a course of brick alongside the rail.

Mr. Hooke prefers the ordinary steam rail section for street railway track. Some of the old Johnson rails are being replaced by deep girder rails of this type, with a row of bricks laid close up under the head of the rail to form a groove, bricks also being laid between their tracks.

The street railway companies are under contract to pave the space between their tracks and for 1 ft. outside, on one side of the track, only, this being a compromise after quite a struggle over the terms of a blanket franchise. Where the companies do not do this work it is done by the city at their expense.

The city cleans its paved streets, removes the sweepings and also collects and removes garbage, ashes and other associated refuse. The hauling is all done under a yearly contract to supply teams. The street sweepings are deposited on vacant lots, and from these piles the manure is culled out and hauled away at will by those desiring to do so. The garbage, ashes and other refuse are mixed together at the houses and used for filling in low streets and adjacent lands. The privilege of the dump, as it is called, is sold yearly to the highest bidder. For 1900 there were an unusual number of bids for this privilege, the highest being $20 per month. The lessee, heretofore, has kept a hog ranch at the dump. When a load of refuse is dumped the hogs make a dash for it and soon dispose of the organic matter. A cheap furnace for burning dead animals has been improvised for use at the dump. The dump is on the river front, about a mile from the center of the city, with no residences near it.

The paved streets are cleaned at night, by sweepers, twice a week in the residence section and every day on the chief business streets, in addition to which there is a push cart day patrol on some of the principal business streets.

The city is divided into nine garbage districts, with a cart for each, and three extra carts for general service. Collections are made twice a week, generally, with a daily service in some sections.

A park outside the city limits was donated to the city a few years ago, aside from which the city owns no parks. The park in question is about five miles distant, at East Lake, and in it there is located a small zoological collection. The city contains a fine natural site for a park known as Cameron Hill. This hill rises quite abruptly from the business section and then pitches down almost precipitously to the Tennessee River. The hill is nearly all waste land now and to an outsider it seems a pity that the city cannot, or does not, gain possession of it while its value is low. Park areas within the city is what will be needed chiefly as soon as the city feels the demand for parks now being met in so many other towns.

Outside and near by is the great government reservation, known as Chickamauga Park, containing some 6,000 acres, and embracing some of the notable battlefields of the Civil War.

The city seems to have done little or nothing, thus far, towards beautifying itself or providing other than strictly utilitarian improvements, but this condition is not peculiar to the newer cities of the country, no larger than Chattanooga. It has great natural advantages in the way of delightful scenery circled about it, but the natural soil is so poor and easily eroded, or else so rocky, that all near views of the hills have a bleak and barren look, even allowing for the disadvantages of winter. It appears that the city is getting more and more smoky, which detracts much from the views to be seen from commanding points, to say nothing of the unpleasantness of grime and soot. Doubtless a large part of the smoke might be avoided with very little trouble or expense, by giving more attention to firing the furnaces and by using more care in selecting coal. The stack of the pumping station of the City Water Co. showed only a little smoke, and that very light, yet a soft coal is used there. The coal is mined in a near by town and is said to give remarkably good results all the time, in the way of freedom from dense smoke. One of the worst appearing chimneys to be seen in or about the city was on the top of Lookout Mt. This chimney was sending out a large volume of dark smoke. Perhaps pains are taken to prevent this smoke at other times in the year. It certainly seems as though commercial reasons, if no other, would lead to more care to prevent smoke on the mountain. Local people, chiefly interested in manufacturing, may put up with smoke, but pleasure seekers from smoke-free towns are not likely to tolerate smoke and soot for many days, nor to make a second visit to a section where such conditions prevail.

Chattanooga has not even a public library, as yet, but Mr. Andrew Carnegie has offered to give the city $50,000 for one, on his usual conditions, namely, that the city will raise annually for the maintenance, a sum equal to 10% of the donation.

The building used as a city hall for the last five years was originally a public market. The people were not accustomed to the idea of a central market and the lessees, too, were dissatisfied with the alleged failure of the city to protect them by ordinances from unlicensed pedlers. The building shelters a portion of the fire department and is in other ways quite unsuited for a city hall.

The city owns a cemetery, located not far from its center, but there are only a few burials in it now, mostly in old family lots.

The city has not reached the point where it feels the necessity or recognizes the advantages of public baths.

Street railway service is afforded by two companies with lines extending into the suburbs, to the national park and cemetery, and to the incline railway up Lookout Mt. There is one electric light and one gas light company, a single telephone company, and the water supply is also furnished by a company.

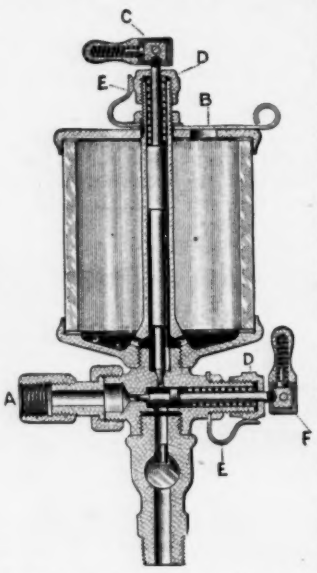
The city has a paid fire department and a fire alarm telegraph system, but no police alarm telegraph.

No electric wires of any kind have been placed underground, but a telephone franchise was granted in the latter part of 1900, which authorizes the grantee to build electrical subways for its own wires and to lease the subways to other companies.

Chattanooga has just had quite an awakening over franchise questions. On Nov. 20 its board of aldermen, without any previous intimation of its intentions, suspended the rules and rushed through, by a vote of 15 to 1, what purported to be a franchise for a rival telephone exchange, but what in vague but apparently broad terms appeared to be, in addition, an exclusive franchise for subways for both pipes and electrical wires. The mayor vetoed the ordinance, but it was passed over his veto, accompanied, however, by a second ordinance, including a contract with the grantee, limiting and defining the original grant and giving the city a percentage of the gross receipts. The mayor's veto and the amendatory ordinance, particularly the latter, were due to aroused public sentiment, that expressed itself by mass meetings and petitions.

AN OIL-CUP FOR PRESSURE OILING SYSTEMS.

The most notable advance in systems of oiling machinery which has been made in recent years, is the introduction of positive pressure systems of lubrication in which the oil is distributed to the various bearings by a system of piping kept under pressure by a slow moving pump. We illustrate herewith a lubricating cup designed especially for use in connection with such systems which has been recently brought out by the Lunkenheimer Co., of Cincinnati, O.



It will be apparent that in any pressure lubricating system it is important that the attendant shall be able to know whether the oil is feeding properly to any particular bearing. It is also often convenient to supplement the supply of oil from the pressure system, for the small pipes sometimes become clogged, and lubrication should continue nevertheless without chance of a shut down.

In the cup, of which a sectional view is shown herewith, a sight-feed chamber is located in the base, so that the rate at which the oil is dropping is under the eye of the attendant. The oil supply from the pressure reservoir is piped through the union A, and the flow is controlled by a needle-valve operated by the lever F. When this is turned down the oil is shut off, so it can be known at a glance whether the valve is open or closed. The auxiliary supply of oil is contained in a glass reservoir, and is not under pressure at all. This auxiliary supply is designed for use in case the pressure supply should be interrupted, and is regulated by the lever C in the same manner as the pressure supply. The spring E holds the regulating valve in any position in which it may be adjusted, so that it cannot be altered by the jarring of machinery.

AMERICAN SLAG CEMENTS.*

By William Kendrick Hatt.†

This paper gives a general account of the nature and properties of slag cement, with tables of chemical analyses, and mechanical strength of various foreign and domestic brands, together with the results of the thesis of Messrs. Anderson, Gordon and Meyers (Purdue, 1900), who obtained the tensional and compressional strength of four brands of American slag cement. It discusses the definition of a Portland and a slag cement and makes the calcination of the product to a clinker the crucial point of distinction between them. A cement made by calcining a mixture of slag sand and limestone might, by the writer's definition, properly be called Portland cement. Slag cement is defined as made by grinding a mixture of pulverized granulated slag and slaked lime, this mixture having been made without applied heat.

An account is given of the development of the slag cement industry, of the various uses in which blast furnace slag has been successful; and of the processes of manufacture and properties of the cement. The appearance of the slag cement is characterized by a delicate lilac color, in some cases almost white. When cement is made from slag by a process involving roasting, the cement is of a dark color like that of ordinary dark colored Portland cement. It has not the coarse or gritty feeling which characterizes most Portland cement. It works fat, sets slowly and passes ordinary tests for permanence of volume.

A pat of slag cement exposed to the air has to be well covered to prevent the surface from cracking. After drying out it will exhibit discolorations (yellowish or brown), whereas the pat hardened under water will not exhibit such discolorations. The characteristic color of the fracture of a water hardened briquette is green, but when the briquette dries out the fracture becomes white. The writer has noticed this green color, with a subsequent change to white, in the case of a well-known American Portland cement, and also the discoloration in the pat. This indicates slag adulteration, or else that there was not a sufficiently oxidizing flame in the kiln. The green color is due to the presence in slag cements of a percentage of sulphide of iron, or sulphide of calcium. This sulphide becomes oxidized on exposure to the air and changes color. Slag cements usually contain from 0.5 to 1.5% of sulphides.

It is this tendency to oxidation on exposure to the air which is destructive to mortar made of slag cements containing sulphides, and makes it necessary to use the product in underground situations or the interior of thick walls. A parallel test of briquettes hardened in air and water should be made to check up the presence of sulphides. This disintegration does not occur in case of all slag cements, and it is not a necessary defect.

The European slag cements which set finally in 6 or 8 hours seem to be more slowly setting than the American cements, which take their final set under the 1-lb. needle, in from two to three hours.

The mechanical strength of the slag cements under tension and compression is quite favorable, although not all equal to that of the better grade of Portland cements. The writer obtained for one of the best of these American slag cements a strength of somewhat above 550 lbs. per sq. in. at the end of the year. Higher values have been quoted, and the average strength of four American brands, under ordinary operations of testing, is given in Table I.

These cements are ground very fine, 99% on 100 sieve in some cases.

In the case of Portland cements, quicklime exists after burning and grinding, and air slaking or ageing is required. Often these Portland cements are sent out too new, the lime being masked temporarily by sulphate of lime. Since in the case of slag cements the lime is completely hydrated, no such danger exists of blowing or swelling; and they are said not to need any ageing. They are also said not to deteriorate on storage.

The presence of a considerable amount of metallic iron in slag cements serves at times as a means of detecting the adulteration of Portland cement with slag. If a magnet is passed several times through these cements, a considerable amount of this metallic iron will cling to the magnet. This amount, however, is variable, sometimes amounting to 0.33% and at other times only 0.1%.

One element of value in the slag cement is that owing to its light color it is said not to stain masonry. This statement has been contradicted. Its specific gravity is considerably less than that of Portland cements; it ranges near 2.8, whereas Portland cements range near 3.10.

The results of the thesis tests made at Purdue University are summarized in Tables 1, 2, 3, 6 and 7, and in Figs. 1, 2 and 6 of the accompanying diagram. The specimens were gaged with enough water for plasticity and hand tamped in molds. The sand was standard crushed quartz, between No. 20 and No. 30 seive. The average re-

*Abstract of a paper read at the annual meeting of the Indiana Engineering Society, Indianapolis, Feb. 15, 1901.
†Associate Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

TABLE I.—Strength of Four Brands of Slag Cement. Average of A, C, D and E—Tension. (Note.—Each value the average of 30 briquettes.)

	Age in days.					
	1	7	28	60	90	Set.
Neat	193	404	477	519	507	In water.
1 : 1	144	390	403	498	483	
3 : 1	39	163	174	208	217	

TABLE II.—Results of Compression Tests. (Each result is average of 5 specimens.)

Days.		Brand. A.		Brand. B.			
7	Neat	2,118	1,609	3,199	2,988	2,7	666
	1 : 1	1,463	1,920	2,983	1,779	2,0	249
	3 : 1	349	463	691	599	6	522
28	Neat	2,724	2,433	2,555	1,871	3,6	216
	1 : 1	2,168	2,153	2,445	2,315	6,4	816
	3 : 1	667	553	748	317	8	727
60	Neat	2,963	3,643	3,511	1,704	3,8	215
	1 : 1	2,805	2,335	2,488	1,235	3,9	507
	3 : 1	733	764	684	274	1,1	892
90	Neat	2,818	2,951	4,919	3,250	....	....
	1 : 1	2,359	2,047	2,987	1,645	....	....
	3 : 1	838	792	1,178	395	....	....
Remarks: Set in		Water.	Air.	Water.	Air.	Wat	Air.

TABLE III.—Chemical Analysis.

	Brand. A.	C.	D.	E.
Lime (Cao.)	55.85	56.55	54.75	53.30
Silica (SiO_2)	28.81	27.48	29.50	28.08
Al. Fe. Oxide ($Al_2O_3Fe_2O_3$)	10.74	10.86	11.02	10.80
Magnesia	1.28	1.75	1.44	3.44
Sulphur as Sulphide	0.353	0.431	0.301	0.472
Sulphur as Sulphate	Trace.	Trace.	Trace.	1.360
Loss on ignition	2.31	3.41	2.73	2.63
Total	99.343	100.481	99.741	100.082

TABLE VI.—Strength of Two Brands of Slag Cement. Average of A and C—tension. (Note.—Each value the average of 20 briquettes in water, 15 in air.)

Age in days..	1	7	28	60	90	Set.
Neat	253	403	477	536	500	In water.
"	162	177	326	378	352	" air.
1 : 1	178	398	469	504	483	" water.
"	162	254	374	321	338	" air.
3 : 1	49	166	173	225	232	" water.
"	46	114	127	106	144	" air.

s for four brands of slag cements are given in Table 1 Fig. 1. The compression tests are given in Table 2 and 2. The chemical analyses are given in Table 3. It is to noted that cement (B) was not by the writer's definiti slag cement, having been made from slag sand and pact limestone, roasted to a clinker as in the ordinary ocess of making Portland cements.

What these results as given mean is not that the ments will not attain a higher strength under other thods of manipulation, but that they are, in the riter's judgment, what may be expected of these ments in ordinary operations of testing, and that with such ordinary operations of testing their strength

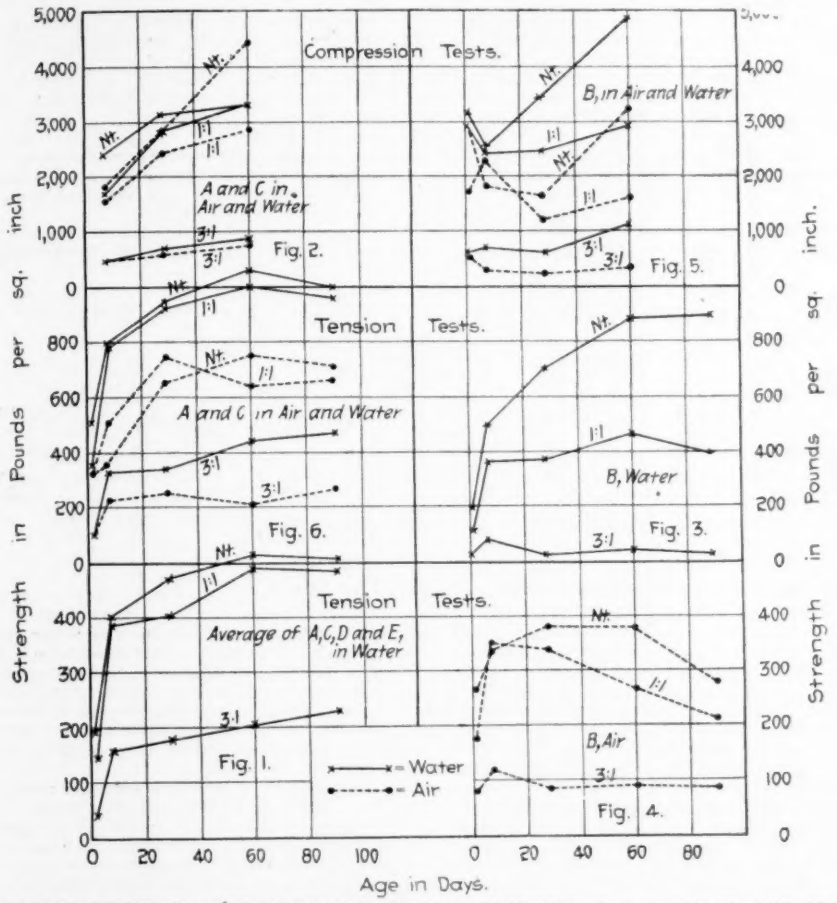
TABLE VIII.—Strength of Air-Hardened in Per Cent. of Water-Hardened Briquettes. Average of A and C.

	Proportions					
	Neat.		1 : 1		3 : 1	
Age.	Tension.	Compression.	Tension.	Compression.	Tension.	Compression.
1 day	71	..	100	..	103	..
7 days	..	74	65	96	79	112
28 "	71	88	81	89	67	86
60 "	84	..	..	86	..	90
90 "	81	..	55	..	46	..
Av. of all...	77	81	78	90	74	96

Fineness on No. 100 sieve in per cent.: A., 98.96; B., 90.10; C., 95.3; D., 99.4; E., 93.7.

briquettes is shown, by which it may be seen that the rate of hardening in air is much less than that in water, but that the air-hardened briquettes do not show any decided falling off in strength during the period of time in which they were under inspection. The comparative rate of gain of these air-hardened briquettes is more clearly shown both for tension and compression in Table 8.

As has been said above, some writers have noticed a decided falling off of strength of slag cements in case of air-hardened briquettes. Other writers have observed no



RESULTS OF TESTS OF FOUR BRANDS OF SLAG CEMENTS—A, C, D AND E; AND ONE BRAND OF CEMENT FROM SLAG MATERIAL, B.

(In Figs. 2, 3, 4 and 5, each point represents the average of 5 specimens. In Fig. 1 each point represents 30 specimens. In Fig. 6 each point represents the average of 20 specimens in water, and 15 specimens in air.)

is sufficient to pass the specification for Portland cements at 7 days and nearly do so at 28 days, as shown below:

	Days—7.	28.	7.	28.
Av. specification Portland.	375 lbs.	531 lbs.	122 lbs.	197 lbs.
Slag	400 "	477 "	163 "	174 "

They will also pass the specifications for time of setting, boiling test and fineness.

In the case of cements (A) and (C), a series of briquettes was made up at the same time as the other briquettes, and allowed to harden in air for various periods, results of which are shown in Tables 2, 6 and 8. As it has been claimed by some writers that slag adulterations of Portland cement can be detected by comparing the strength of water-hardened and air-hardened briquettes, these tests have an interest. In Fig. 6 the comparative strength of water-hardened and air-hardened

TABLE VII.—Strength of Two Brands of Slag Cement. Average of A and C—Compression. (Note.—Each value the average of 10 briquettes.)

Age in days	1	7	28	60	90	Set.
Neat	...	2,452	3,205	3,389	...	In water.
"	...	1,807	2,824	4,429	...	" air.
1 : 1	...	1,739	2,818	3,553	...	" water.
"	...	1,584	2,484	2,921	...	" air.
3 : 1	...	515	738	945	...	" water.
"	...	542	640	828	...	" air.

such falling off in strength nor any deficiency in the strength of air-hardened briquettes compared to water-hardened briquettes. For instance, tests at Boulogne up to six years show noticeable differences between water-hardened and air-hardened briquettes. Prof. Tetmayer has found no difference at all for one brand. M. Deval has found almost an entire loss of strength in air-hardened briquettes. It doubtless depends on the qualities of a particular batch of cement; excess of sulphides would no doubt evidence itself in this way.

The average results in Fig. 6 were confirmed by individual tests, except in the case of cement (C), where the neat briquettes in air were as strong as the neat briquettes in water and the sand tests show a falling off of strength when tested in water. In case of cement (A), a series of briquettes was hardened in the air of the laboratory, and another series of briquettes was hardened when exposed to the atmosphere during the winter months, being tested after having been taken from the outdoor air. These outdoor briquettes, while not as strong as the water-hardened briquettes, are, in case of the sand mixtures, stronger than the same briquettes when hardened indoors. In Fig. 6 both the indoor and outdoor briquettes are included in the average.

The results of tests by different operators under parallel conditions, on the same brand of cement showed a fair agreement. A few eccentric individual values have been discarded after a thorough analysis of the results.

Since the calcined cement (B) was not evidently of the same class as the other four cements, it has been worked up and represented separately.

The average ratio of the tensile to the compressional strength was as 1 to 6.4. This ratio is as follows: Water-hardened, 1 to 5.3; air-hardened, 1 to 7.4.

The chemical tests were made by Mr. M. M. Smith, a student in the chemical laboratory of Purdue University working under the direction of Dr. P. N. Evans, Professor of Chemistry.

The cements under examination show a favorable strength, fineness and time of set. They kept their strength during the 90 days they were under observation. The strength obtained by air-hardened briquettes in tension was only 75% of that obtained by water-hardened briquettes.

There are six mills manufacturing slag cement and, in addition, two mills manufacturing a roasted product of which one element is slag sand.

RECENT DESIGNS OF BATTLESHIPS AND CRUISERS FOR THE UNITED STATES NAVY.*

By Rear-Admiral Philip Hichborn, Chief Constructor, U. S. Navy.†

(With two-page plate.)

As we all know, warship design is, of necessity, a compromise, and it is the province of those responsible for the ultimate success of the design so to apportion the various essential elements as to produce the most efficient man-of-war. Results so obtained are never free from criticism, and those specially concerned may allege with complete good faith that undue sacrifices have been made in some one or more of the qualities of manœuvring power, armament, defensive power, speed, coal endurance, or some other element, in order that one more favored should have greater development. However true such criticism may be in the abstract, it is frequently misleading and sometimes provokes acrimonious discussion without resultant benefits.

The designs described in this paper are the result of much thought and serious consideration on the part of those ultimately responsible for their success or failure, but possibly will not meet with unqualified approval in all quarters. It can be stated with complete assurance, however, that they embody in an unusually well developed degree all the elements of seaworthiness, offensive and defensive power, speed and coal endurance, and that, in all essentials, they are superior to all previous designs of similar character produced in this or any other country.

While the designs prepared by the department embody the features considered most essential for vessels of their class, and in general dimensions, distribution of battery, design of propelling machinery, and general interior arrangements represent the latest and best practice in warship design, the circulars defining the chief characteristics of the vessels embraced in the recent programme, allow certain latitude to prospective builders in submitting their bids and accompanying plans, and it is not improbable that minor changes from the department's designs may be permitted in the plans finally accepted; but it is believed that there will be no material departures from the general plans accompanying this paper.

THE BATTLESHIP CLASS.

The five battleships included in the present shipbuilding programme are identical in general dimensions, protection, and interior arrangements, with the exception that three vessels have four of the 8-in. guns in superposed turrets, and are sheathed, while the other two vessels are unsheathed and have the eight 8-in. guns in pairs in four turrets, quite independent of the 12-in. turrets. The most noteworthy departures from previous designs are increased length, which has been necessitated by the increased speed and coal endurance demanded by many advanced strategists, inclined armor at the forward end of the redoubt, an arrangement of the casemate armor which permits the broadside battery to be snugly housed without dismounting, and the substitution of water-tube for the conventional Scotch boilers.

The battery carried by these vessels is unquestionably the heaviest battery afloat. The arrangement of the battery is such as to give a powerful bow, stern and broadside fire, and, for the 12-in. and 8-in. guns, the American system of mounting in turrets has been adhered to.

In general, the armor protection consists of a complete water line belt about 8 ft. in width, having a thickness throughout the engine and boiler space of 11 ins. at the upper edge and 8 ins. at the lower edge, the section being as shown by the sections, Figs. 2 to 7. Forward and abaft the machinery space the armor is gradually reduced in thickness until at the bow and stern it has a uniform thickness of 4 ins. Above the main belt and protecting the central portion of the vessel for a length of about 245 ft., and extending from the main belt to the upper or main deck, armor 6 ins. in thickness is worked—this upper and lower casemate side armor being connected to the barbette of the after 12-in. turret by athwartship armor 6 ins. in thickness and completed forward by inclined ar-

*Abstract of a paper read at the eighth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 15 and 16, 1900.

†Washington, D. C.

mor 6 ins. in thickness, the whole forming a central casemate or redoubt containing twelve 6-in. guns. The secondary battery of 14-pdr. guns will be protected by 2-in. nickel steel plates of sufficiently large area to afford efficient protection to the guns' crews.

The barbettes for the 12-in. guns will be of 10 ins. in thickness, except for those portions within the casemate, whose thickness is reduced to 6 ins. The armor of the 12-in. gun turrets will be 10 ins. in thickness, except the port plates, which will be 11 ins. thick. The tops of the 12-in. turrets will be 3½ ins. thick for vessels of the Pennsylvania class fitted with superposed turrets, and 3 ins. for those of the Virginia class with detached turrets. The armor of the 8-in. turrets and barbettes will be 6 ins. thick, except the turret port plates, which will be 6½ ins. The tops of the 8-in. turrets will be protected by 1½-in. plates, while the conning tower will be formed of 9-in. plates, with a connecting armored tube 6 ins. in thickness. In addition to the armored casemate the 6-in. guns on the main deck are to be further protected by splinter bulkheads of 2½-in. nickel steel between each pair of guns.

The approximate weight of the above armor is as follows:

Total armor, etc.	3,344	tons.
Backing	178	"
Bolts	68	"
Total armor, etc., bolts and backing	3,590	"
Cellulose	100	"
Total hull protection	3,690	"

Special provision will be made for insulating magazines by air spaces, and also for cooling them by direct connections with the refrigerating plant.

The battery will consist of four 12-in. B. L. R., 40 calibers in length, eight 8-in. B. L. R., 45 calibers in length, and twelve 6-in. B. L. R., 50 calibers in length. The secondary battery will consist of twelve 3-in. B. L. R. (14-pdrs), twelve 3-pdrs, four 1-pdrs (automatic), four 1-pdrs. have a rated output of 625 amperes each at 80 volts. The electric generating plants for the vessels of the "Virginia" class will be similar to the above, except that there will be eight units with a rated output of 625 amperes at 80 volts, and two units with a rated output of 1,250 amperes at 80 volts.

ARMORED CRUISERS.

The armored cruisers, six in number, will have a length of 502 ft., beam 69 ft. 6 ins., and a trial displacement of 13,400 tons on 24 ft. 6 ins. draught, the coal bunker capacity being 2,000 tons.

The armored cruisers outlined in the accompanying plans (Figs. 9 to 14) are identical in dimensions, interior arrangements and batteries, the only variation being that three are sheathed with wood and coppered and three are unsheathed. They are designed for a speed of at least 22 knots and will have a very large radius of action. The following particulars taken from the official circular defining the chief characteristics of these vessels describe the most important details of armor, armament and propelling machinery:

ARMOR.—A water-line belt 7 ft. 6 ins. in width, to extend the entire length of the vessel; this belt, for a distance of about 244 ft. abreast of the engines and boilers to consist of armor 6 ins. in thickness at the upper edge and maintaining this thickness downward for a distance of 4½ ft., from which point it tapers to 5 ins. at its lower edge. The belt is to be completed to the bow and stern by armor plates having a uniform thickness of 3½ ins. Above the main belt the side will be protected by armor 5 ins. in thickness for a length of about 232 ft., extending vertically to the main deck. Transverse armor 4 ins. in thickness is to be worked in at the ends of this 5-in. side armor, thus forming a central casemate for ten 6-in. guns. The four 6-in. guns on the upper deck at the corners of the superstructure are to be protected by armor of 5 ins. in thickness. The armor for the 8-in. turrets will be 6 ins. in thickness, except the port plates which will be 6½ ins. in thickness. The tops of the 8-in. turrets will be of neckel steel 1½ ins. in thickness. The top of the conning tower will be of nickel steel 2 ins. in thickness. The barbettes for the 8-in. turrets will have a uniform thickness of 6 ins. The ammunition tubes for the 8-in. turrets will be 3 ins. in thickness. The conning tower will be 9 ins. in thickness, and its tubes 5 ins. in thickness. The signal tower will be 5 ins. in thickness. The main armor belt is to be so placed that its upper edge will be at least 12 ins. above the water line at maximum deep-load draft. In addition to the armored protection, the 6-in. guns on the gun deck are to be further protected by splinter bulkheads of 2½-in. nickel steel between each pair of guns.

The estimated weights of the above armor, etc., are as follows:

Total armor, etc.	1,976	tons.
Bolts	43	"
Backing	100	"
Total armor, etc., bolts and backing	2,119	"
Cellulose	100	"
Total protection	2,219	"

A protective deck of nickel steel is to extend throughout the vessel, and will be 1½ ins. thick on the flat and 4 ins. thick on the slopes. A cellulose belt, about 3 ft. thick, of approved material, is to be worked along the sides above the protective deck the entire length of the vessel.

ARMAMENT.—The armament will be mounted as follows: Four 8-in. guns, in pairs, in two electrically controlled, elliptical, balanced turrets, having inclined port plates, one forward and one aft, on the line of the keel, and having an arc of fire of 270°. On the upper deck at the corners of the superstructure four 6-in. guns will be mounted in sponsons, one at each corner, each having an arc of fire of not less than 145°. On the main or gun deck ten 6-in. guns in broadside will be mounted, five on each side, having an arc of fire of not less than 110°; that is, 55° forward of and abaft the beam, except the forward pair, which are to be sponsoned and will fire directly ahead. The secondary battery will be mounted in the most commanding positions, having as large an arc of fire as possible; the automatic 1-pdrs. to be mounted in the lower military tops, and two single-shot 1-pdrs. in each upper military top.

Suitable means will be provided for a rapid and efficient supply of ammunition for all the guns of the main and secondary batteries. The rate at which ammunition will be supplied to the 8-in. turret hoists is one complete round of powder and projectile to each hoist every fifty seconds. The rate of supply of ammunition for the 6-in. guns will be three complete rounds per minute to each gun. The rate of supply of ammunition for the 14-pdr. guns will be six rounds per minute to each gun. The rate of supply of ammunition for the 3-pdr. and 1-pdr. guns will be ten runs per minute to each gun. The following are the ordnance weights: Armament, 407 tons; ammunition, etc., 432 tons.

ELECTRIC PLANT.—The electric generating plant will consist of seven units, each unit to consist of an engine and dynamo mounted on a combination bed-plate. Three units shall have a rated output of 1,250 ampheres each at 80 volts and four units shall have a rated output of 625 amperes each at 80 volts. The total weight of the seven units complete must not exceed 141,000 lbs. The total weight of the whole electric installation, including dynamos, engines, bed-plates, all fittings, wiring, tools, stores, instruments and six searchlights, must not exceed 158.7 tons.

PROPELLING MACHINERY.—The engines will be of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined I. HP. of 23,000. The steam pressure at the engines will be 250 lbs. The stroke will be 4 ft. The ratio of cylinders will be at least 1 to 7.30, and the diameters will be sufficient for the required I. HP. at about 120 revolutions per minute. Each engine will be located in a separate water-tight compartment. They will be provided with all the necessary auxiliaries and accessories in accordance with the latest practice of the Bureau of Steam Engineering.

There will be thirty boilers of the straight water-tube type, placed in eight water-tight compartments. They

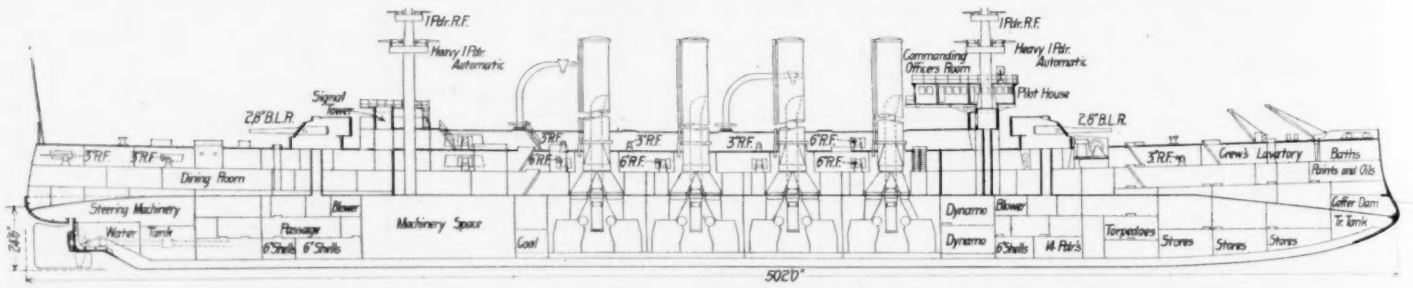


FIG. 8.—LONGITUDINAL SECTION OF ARMORED CRUISER, "MARYLAND" CLASS.

(single shot), two 3-in. field guns, two machine guns, six 0.30 caliber automatic guns, and two submerged torpedo tubes.

The four 12-in. guns are mounted in pairs, on the middle line of the vessel, in electrically controlled balanced, elliptical turrets, having an arc of fire of 270°. Of the eight 8-in. guns of the Pennsylvania class, four will be mounted in pairs in two elliptical turrets superposed on, and rigidly connected to the 12-in. turrets, and four in pairs in two electrically controlled elliptical, balanced turrets, with inclined port plates, one on each beam, and with an arc of fire of 180°. The eight 8-in. guns of the Virginia class will be mounted in pairs in four electrically controlled elliptical, balanced turrets, with inclined port plates, one on each beam near the forward end of the superstructure, and one on each beam near the after end of the superstructure—the guns so mounted to train through an arc of 145°. The twelve 6-in. guns will be mounted in broadside on the gun deck, six on each side, and will have an arc of fire of 110°.

There will be ample provision for supplying ammunition to the guns, the chains of supply being so distributed that there will be a complete round of powder and projectiles delivered by each 12-in. turret hoist every 90 secs., one complete round of powder and projectiles by each 8-in. turret hoist every 50 secs., and a supply of ammunition for the 6-in. guns sufficient to provide three complete rounds per minute for each gun. The rate of supply of ammunition for the 14-pdrs. will be 6 rounds per min., and for the 3-pdr. and 1-pdr. guns, 10 rounds per min. for each gun. There will be two submerged torpedo tubes, located in one compartment.

The approximate weights of ordnance outfit is: Armament, 805 tons; ammunition, 612 tons.

The main propelling machinery will consist of twin screw, vertical, four-cylinder, triple-expansion engines of a combined I. HP. of 19,000, on a steam pressure of 250 lbs. and about 120 revolutions per minute. There will be 24 boilers of the straight water-tube type, placed in six watertight compartments. The weight of the machinery, tools, stores and spare parts will be about 1,730 tons.

The electric generating plant for the vessels of the "Pennsylvanna" class will consist of eight units, each unit comprising an engine and dynamo mounted on a combinatio bed plate. Two units will have a rated output of 1,250 amperes each at 80 volts, while the other six units will have at least 1,590 sq. ft. of grate and about 68,000 sq. ft. of heating surface, and must be able to furnish steam for the main engines and all the necessary auxiliary machinery and other steam machinery throughout the ship, with an average air pressure in the ash pits of not more than 1 in. of water. All the necessary auxiliaries and accessories will be provided for the efficient working of the boilers.

The weight of all machinery and tools, stores and spare parts will be about 2,000 tons. This weight will include all articles, irrespective of name or use, coming under the cognizance of the Bureau of Steam Engineering, including water in boilers, condensers, piping, etc., but excluding the reserve feed water in the double bottom or tanks.

PROTECTED CRUISERS.

The protected cruisers will have a length of 424 ft., beam 66 ft., and a trial displacement of about 9,700 tons on 23 ft. 6 ins. draft, the coal bunker capacity being 1,500 tons.

ARMOR.—The armored protection will be as follows: A partial water-line belt about 200 ft. in length abreast the engines and boilers, this belt being 7 ft. 6 ins. in width and 4 ins. in thickness. Above the main belt the sides of the ship will be protected for a distance of about 133 ft. in length by vertical armor about 7 ft. in width and 4 ins. in thickness, the forward and after ends being connected by transverse armor 3 ins. in thickness. Above the lower casemate the sides of the ship will be protected for a distance of about 133 ft. in length by vertical armor about 7 ft. 2 ins. in width and 4 ins. in thickness, with transverse armor 3 ins. thick connecting the ends and forming a central casemate with four armored sponsons. On the main deck the four 6-in. guns at the corners of the superstructure will be protected by vertical armor 4 ins. in thickness and about 7 ft. 6 ins. in height in the form of sponsons. There will be an oval conning tower, 6 ft. and 8 ft. inside diameters and 8 ft. in height, with a shield, both tower and shield being 5 ins. in thickness, with a top 3 ins. in thickness. The conning tower will have an armored tube 3 ins. in thickness, extending to the protective deck. There will be a signal tower 8 ft. 6 ins. in height, 6 ft. in diameter, and 4 ins. in thickness. The main armor belt is to be so placed that the upper edge will be at least 15 ins. above the water line at maximum deep-load draft. The 8-in. guns on both decks will

be further protected by splinter bulkheads of 2-in. nickel steel placed between each pair of guns on the gun deck. The estimated weights of the above armor, etc., are:

Total armor, etc.	760	tons
Bolts and nuts	28	"
Total armor, etc., bolts and nuts	788	"
Cellulose	66	"
Total protection	854	"

A protective deck of nickel steel is to extend throughout the vessel, and will be 2 ins. thick on the flat and 2½ ins. thick on the slopes. On the slopes this deck will be laid on ½-in. steel plates. There will be a cellulose belt, about 2½ ft. thick, of approved material, in coffer-dams, worked along the sides above the protective deck the entire length of the vessel.

ARMAMENT.—On the main deck will be mounted six 6-in. guns on pedestal mounts, with shields. Two of these guns will be mounted on the middle line of the vessel, one forward and one aft, each having an arc of fire of not less than 270°. The other four 6-in. guns on the main deck will be mounted in sponsons at the corners of the superstructure, the forward pair having an arc of fire of 145°, viz.: from right ahead to 55° abaft the beam, and the after pair having an arc of fire of 145°, viz.: from right astern to 55° forward of the beam.

On the gun deck, eight 6-in. guns will be mounted, four on each broadside, in a central casemate, the forward and after pairs being in sponsons directly under the 6-in. guns at the corners of the superstructure on the deck above. The forward pair will have an arc of fire of 85° forward of and 55° abaft the beam, and the after pair an arc of fire of 85° abaft and 55° forward of the beam. The four waist guns will each have an arc of fire of 55° forward of and abaft the beam.

Twelve 14-pdrs. will be mounted on the gun deck, three forward and three aft on each side. Six 14-pdr. guns will be mounted within the superstructure, three on each side. The twelve 3-pdr. semi-automatic guns will be mounted on the superstructure deck. In the lower military tops the four heavy 1-pdr. automatic guns will be mounted, two on each mast. In the upper military tops four heavy 1-pdr. rapid-fire guns will be mounted, two on each mast. The remaining four heavy 1-pdr. rapid-fire guns will be mounted on the gun deck, two forward and two aft. Arrangements will be made whereby all the guns which do not train fore and aft, or nearly so, can be quickly and conveniently dismounted, housed, and secured, so as to leave the ship's side practically clear.

There will be a sufficient number of electric-power hoists direct from the magazines to the battery decks to furnish an ample supply of ammunition to all the guns of the main and secondary batteries; also suitable means for supplying the guns in the tops. The rate of supply of ammunition for the 6-in. guns will be not less than six complete rounds to each gun per minute. The rate of supply of ammunition for the 14-pdr. guns will be not less than 15 rounds to each gun per minute. The rate of supply of ammunition for the 3-pdr. guns will be not less than 30 rounds to each gun per minute, and for the 1-pdr. rapid-fire guns not less than 30 rounds to each gun per minute, while for the 1-pdr. automatic guns the supply will be not less than 100 rounds to each gun per minute. The ordnance weights are: Armament, 270 tons; ammunition, etc., 643.1 tons.

PROPELLING MACHINERY.—The engines will be of the vertical, twin-screw, four-cylinder, triple-expansion type, of a combined I. HP. of 21,000. The steam pressure will be 250 lbs. The stroke will be 45 ins. The ratio of high pressure to low pressure will be at least 1 to 7.30, and the diameters will be sufficient for the required I. HP. at about 133 revolutions per minute. Each engine will be located in a separate water-tight compartment. They will be provided with all the necessary auxiliaries and accessories in accordance with the latest practice of the Bureau of Steam Engineering.

There will be 16 boilers of the straight water-tube type, placed in four water-tight compartments. They will have at least 1,400 sq. ft. of grate and 58,800 sq. ft. of heating surface, and must be able to furnish steam for the main engines and all the necessary auxiliary machinery with an average air pressure in the ash pits of not more than 1 in. of water. All the necessary auxiliaries and accessories will be provided for the efficient working of the boilers.

The weight of all machinery and tools, stores, and spare parts will be about 1,000 tons. This weight must include all articles, irrespective of name or use, coming under the cognizance of the Bureau of Steam Engineering, including water in boilers, condensers, piping, etc., but excluding the reserve feed water in the double-bottom or tanks.

ELECTRIC PLANT.—The electric generating plant will consist of five units, each unit to consist of an engine and dynamo mounted on a combination bed-plate. Two units shall have a rated output of 1,250 amperes each at 80 volts, and three units shall have a rated output of 625 amperes each at 80 volts. The total weight of the five units complete must not exceed 100,000 lbs. The total weight of the whole electric installation, including dynamos, engines, bed-plates, all fittings, wiring, tools, stores, instruments, and six searchlights, must not exceed 123 tons.

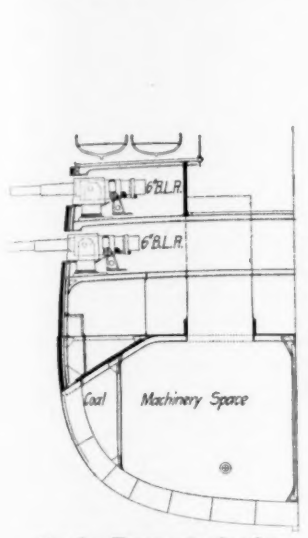


Fig. 9.—Transverse Section Through Machinery Space and 6-in. Gun Mounts.

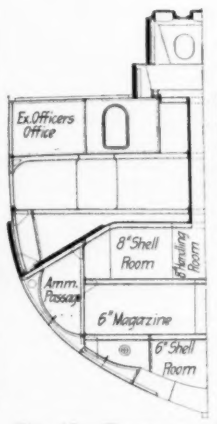


Fig. 10.—Transverse Section Through After Turret.

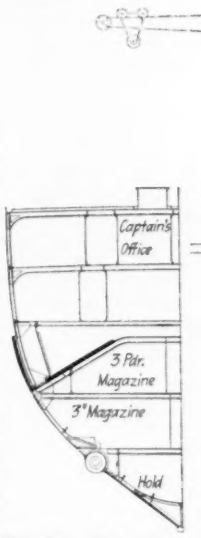


Fig. 11.—Transverse Section at Frame 105, Near Stern.

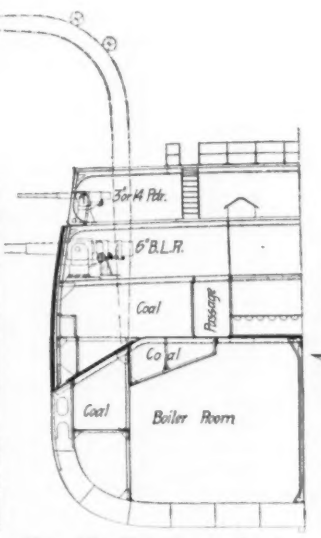


Fig. 12.—Transverse Section Through Boiler-Room.

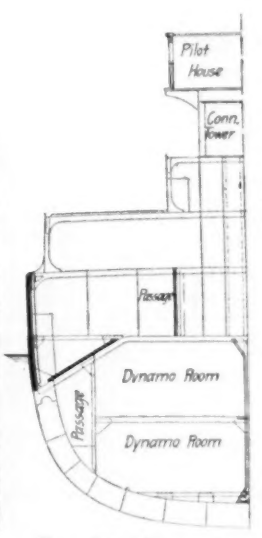


Fig. 13.—Transverse Section Through Conning Tower.

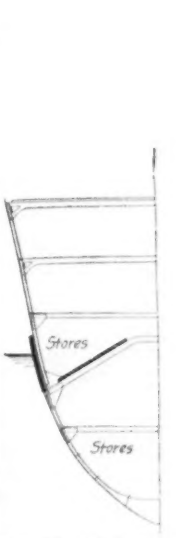


Fig. 14.—Transverse Section at Frame 18, Near Bow.

FIGS. 9 TO 14.—TRANSVERSE SECTIONS OF CRUISER "MARYLAND."

BOOK REVIEWS.

LA NAVIGATION SOUS-MARINE (SUBMARINE NAVIGATION).—By Maurice Gracet. Paris: Ch. Beranger, 21 Rue de la Regence. Cloth; 8vo.; pp. 472; illustrated. $3.

Submarine boats for naval purposes have been the dream of many inventors, and a few successful boats of this kind, having a limited field of usefulness, have been used in experimental service. After referring to ancient diving vessels, more or less mythical, the author states that the first real submarine boat was built by Cornelius von Drebbel, a Dutch doctor at the court of James I. of England; this boat was operated on the Thames and the king made a trip in it. Other inventors followed in France and England, and in 1773 an egg-shaped submarine torpedo boat was invented by an American, David Bushnell. In 1776 Sergeant Ezra Lee, U. S. A., endeavored to place a torpedo under one of the English warships in New York Harbor with the aid of this vessel. The strength of the tide, however, made the boat difficult to handle, and the copper sheathing of the warship prevented the attachment of the torpedo, which floated away and was exploded harmlessly later on. Since then numerous inventors have attacked the problem, including Fulton, Nasmyth and Nordenfeldt, the latter of whom in 1885 built a vessel for the Turkish government.

In a separate chapter of about 70 pages modern submarine boats are described and illustrated. These include the "Goubet," "Gymnote," and "Gustave Zede," of France; the "Peral," of Spain, and the "Holland," of the United States. The author believes that the Americans have now advanced as far as the French in having solved the problem of simple navigation under water. It now remains to make the vessel reliable for naval purposes. "The Americans do not seem to attach the least importance to the limited extent and the indistinctness of the field of vision. Perhaps in France we exaggerate this difficulty."

A somewhat mathematical chapter is devoted to the exterior form of submarine boats, and another chapter discusses the motive power equipment, including steam boilers, electric batteries and motors. The problems of immersion, of sinking vertically or on inclined planes, and of directing the movements of the vessel vertically and horizontally by screws, rudders, water ballast tanks, vertical screws, fins, etc., are also considered at considerable length, as is also the problem of supplying air to the men.

In regard to the value of the submarine boat in warfare, it is stated that the boat could safely approach within a mile of the ship to be attacked without much fear of being seen. When the captain or engineer thinks he is within about one-third of a mile of the ship he may rise for a moment to the surface to verify his bearings, and then proceed on his course. The automobile torpedo may be launched at a distance of about 800 ft., though when it is aimed at a moving ship it will be a delicate matter to be sure of striking it. A long chapter is devoted to war and the possibilities of the submarine torpedo boat in war, in which the author (being a Frenchman) discusses the war with England which the French are so fond of discussing. It cannot be said, however, that there is anything very practicable in this part of the book, either as to the vessels themselves or their use.

One chapter is devoted to automobile torpedoes, and another to the optic tube by which a system of mirrors will show in the submerged boat a view of a certain portion of the surface. This device, however, will be of little value except in the smoothest water, and its range of vision will be small.

SPECIFICATIONS FOR STEEL BRIDGES.—By J. A. L. Waddell, M. Am. Soc. C. E. New York: John Wiley & Sons. Cloth; 4½ × 7 ins.; pp. 156; illustrated. $1.25.

The considerable demand by draftsmen and computers for the series of specifications for steel bridges published in the author's "De Pontibus" has led to their publication by themselves in the present book, at a price which is about one-third that of the larger book. In making this reprint, the author has taken advantage of the occasion to modify and bring up to date any of the clauses of the original specifications in which such alterations seemed advisable. Among these modifications those of most importance are: the preparation of live-load diagrams for the heaviest engines now being built; the adoption of increased head room for railway bridges; the adoption of expansion rollers surrounded with oil, and several changes in the percentages of elongation, tests of full size members and allowable working strains. The original specifications published in "De Pontibus" are so well and favorably known that little space need be taken in presenting their various features here. They are presented in compact form and convenient size in the present book, and at a price which makes them more widely available than was possible in their original form.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, ... PRESIDENT.
D. McN. STAUFFER, ... VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, . . . TREASURER AND BUSINESS MANAGER.

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ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.60 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current year,* 15 *cents.*

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We alluded last week to the failure of the reciprocity treaty plan of lowering the tariff. Additional particulars from Washington show the completeness of the failure. The very idea at the basis of the reciprocity treaty plan is, of course, that of mutual concession. The United States cannot get something for nothing; and if a foreign country reduces its tariff rate on certain goods of our production, it will only do so when reductions of equivalent value are promised in the United States tariff. It happens, however, that a two-thirds vote of the Senate is required to ratify a treaty, and when the rival interests brought pressure to bear upon the Senate, it was much easier to secure one-third to prevent ratification than two-thirds to secure it. The situation is tersely summed up in a statement by Hon. John A. Kasson, the U. S. Commissioner who negotiated the treaties, which is quoted in the "Iron Age" as follows:

> It is not practicable for the United States to negotiate reciprocity treaties that shall contain no concessions on its part except as to goods which it does not produce. If this view of the principle of reciprocity is to be maintained, the further discussion of the pending treaties or the negotiation of other treaties must be a waste of time.

In the article on slag cements by Prof. Wm. K. Hatt, which is published elsewhere in this issue, reference is made to a possible method of determining the presence of slag adulteration in Portland cements. This method appears likely to prove of practical value to cement users. The article points out that the characteristic color shown by a water-hardened pat or briquette of slag cement, when fractured, is green, but that upon drying by exposure to air this green color bleaches to white. This change of color is due to the presence in slag cements of from 1 per cent. to 1½ per cent. of sulphides, which upon exposure to air are oxidized. A similar coloration and bleaching action is witnessed when a Portland cement has undergone faulty calcination, because there was not a sufficiently oxidizing flame in the kiln. The fact, therefore, that a Portland cement briquette hardened in water bleaches from green to white upon exposure to air is only presumptive evidence that slag adulteration has been practiced; it may be the result of faulty calcination. In either case the fact is one whose determination is of value to the engineer, since it gives him warning that the character of his cement supply is open to suspicion. The use of ground slag as an adulterant of Portland cements is well known, particularly in Europe, where cement users have been compelled to take stringent measures to protect themselves from the fraud. In America, far less tendency has been shown by cement manufacturers to practice adulteration; but it is nevertheless certain that it is sometimes done. As large quantities of European cements are used in America each year, it behooves the careful engineer to watch for the possibility of adulteration, and so far as slag adulteration is concerned, the phenomenon noted by Prof. Hatt is a valid reason for suspecting fraudulent practice, although it would need to be substantiated by further evidence to be accepted as definite proof of such practice. The practical value of the indication lies in the fact that it may be observed in the regular course of making the pat test for constancy of volume.

The recent decision against the Berliner telephone patent is giving rise to numerous predictions that the telephone business will now be open to free competition. The prophets who venture such remarks overlook the fact that the telephone business is a natural monopoly anyway, even more so than the telegraph business; and not at all a proper field for competition. Of course, it is true that the patents of the Bell Co. were originally of great aid to it in securing control of the business. Their annulment at the present time, however, while it might stimulate competition in the manufacture and sale of instruments, could do nothing to foster competition in the business of furnishing telephone communication.

Our usually accurate contemporary, "The New York Journal of Commerce," commenting on the recent decision in the Berliner case, says:

> It would be almost impossible to frame a more tremendous indictment of the Patent Office than the decision of Judge Brown. * * * * The history of the Berliner transmitter patent proves that the Patent Office should be abolished or radically reformed.

Our contemporary is placing the blame in the wrong place. The Patent Office authorities are helpless against such delays in the issuance of patents as occurred in the Berliner case. They can only execute the laws as they find them. In the very latest report of Commissioner Duell, Congress is urged to amend the patent laws so that applicants shall be obliged to use due diligence in putting their papers in shape for final action. What is needed is such radical reform in Congressional procedure as to enable it to enact legislation of public importance. Reforms in a thousand directions are hopeless till this is accomplished.

THE UNITED STATES STEEL CORPORATION.

Of all the industrial consolidations which have been carried on at so rapid a rate during the past three or four years, none have interested engineers so directly as those which have taken place in the iron and steel industry. The kaleidoscope of change has been so swift here that men have hardly had time to accustom themselves to a new set of conditions before they were upset by still another change. For a typical illustration, we may take the Bessemer works at Joliet, Ill., originally built as an independent enterprise in 1870. Some time in the '80's this works was consolidated with three works located in Chicago to form the Illinois Steel Co. In 1898, that concern was combined with the Minnesota Iron Co., the Lorain Steel Co., and the Elgin, Joliet & Eastern R. R. Co., to form the Federal Steel Co., with a capitalization of $200,000,000. Now, after two years' operation of this corporation, it is absorbed by the huge new United States Steel Corporation, with its colossal capitalization of $1,154,000,000.

The public interest in this vast consolidation is far more than mere curiosity. Thousands and hundreds of thousands are dependent upon the iron and steel industry for a livelihood. Millions have interests that may suffer harm or benefit, according to the course which the managers of this concern may pursue. Yet it is significant that all these millions were powerless to help or to hinder the revolutionary change that has taken place. Even the stockholders of the companies absorbed, save for a few owners of large interests, were in ignorance as to what was about to be done with their properties. Indeed, it is said that the whole scheme of consolidation was planned and carried into effect by not more than half a dozen men. To such an extent has the divorcement of ownership from control been carried in the modern industrial world.

According to the best published estimates, the new corporation controls blast furnaces with a capacity of 6,500,000 tons per annum, or nearly half the total pig iron production of the United States in 1900. All its blast furnace product, moreover, will be converted to steel and will finally reach the market as tin plate, sheets, wire, tubing, hoops, rails, structural shapes, or some other of the many finished forms of steel. All this, of course, will be done in the company's own mills, and as it controls its own iron mines, steamers and railways, it has in its own hands every operation from the time the ore is in the earth until it reaches the final consumer.

A good idea of the extent to which the new company dominates the steel industry is given by the above figures. Since it controls nearly half the pig iron production, and since a very large proportion of the other half of the pig iron product is sold directly to the foundry trade, it will be apparent that the new company controls much more than half the steel producing capacity of the United States.

We gave last week the list of the companies whose properties are united in the new corporation. The following is an estimate of their respective net earnings in 1900:

Carnegie Steel Co	$39,000,000
American Steel & Wire Co	7,000,000
Federal Steel Co.	15,000,000
National Tube Co.	13,000,000
American Tin Plate Co	4,600,000
National Steel Co.	6,000,000
American Steel Hoop Co.	3,000,000
American Sheet Steel Co.	5,000,000
Total	$92,600,000

These figures are only approximations; actual figures not being attainable. They will serve, however, as an indication of what the associated companies have done during a year of the most prosperous period that the steel industry has seen in two decades. What the consolidated company can earn in years of bad business; and how it could meet such a panic as that of 1894, are things that only the future can develop.

From one point of view, the new combination is founded on a much less stable basis than most of the previous trusts, in that it starts out with a huge bonded indebtedness, amounting to $304,000,000, bearing the high rate of interest of 5%. This means, of course, that the company must make over $15,000,000 net earnings each year or become bankrupt. Whether this is all the fixed charges which the new company will have to stand is not known; but it is certain that the constituent companies had more or less outstanding bonds, which will have to be provided for in some way.

It is commonly believed that the bond issue of the new company was only inserted as a necessary feature to enable the Carnegie properties to be acquired. In fact in the official circular to stockholders it is stated that the new company's bonds are to be used only to acquire the bonds and 60% of the stock of the Carnegie Steel Co. It will be entirely clear from the above estimate of earnings why Mr. Carnegie and his partners were in no deep anxiety to sell to the new combination; and why cash or bonds were more attractive to them than a preferred stock, dividends on which would be subject to all the uncertainties of fu-

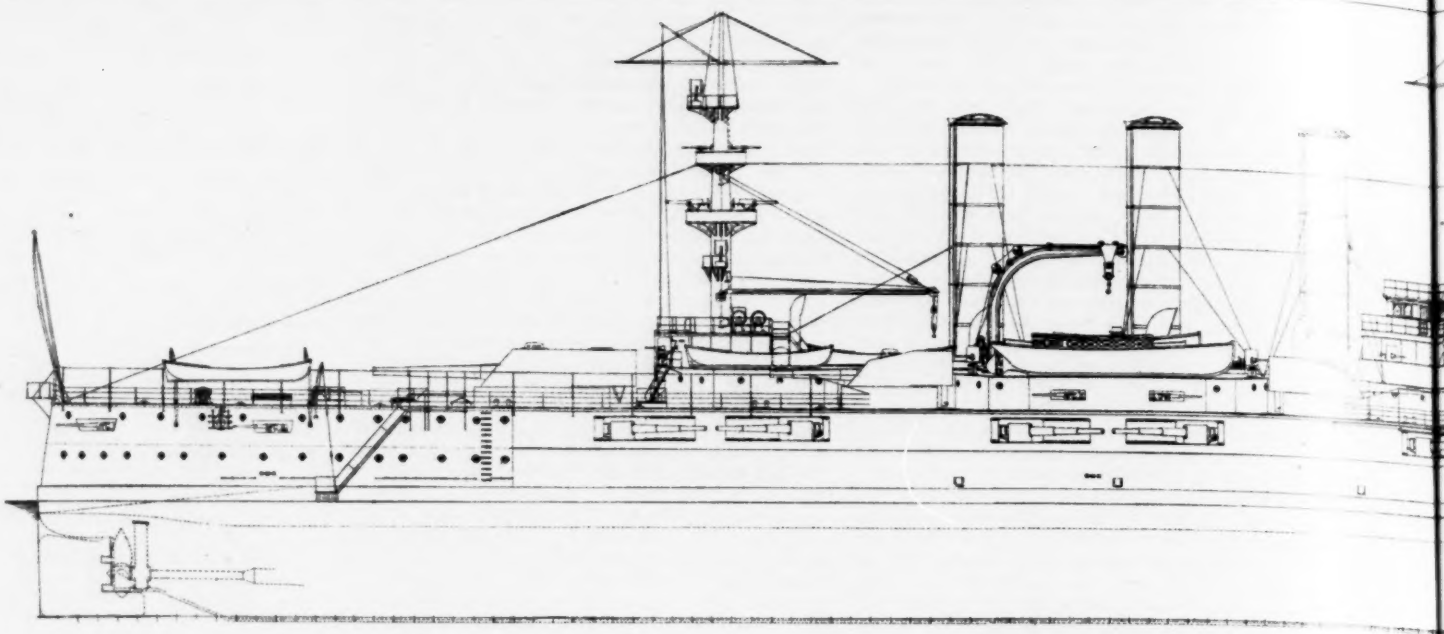


FIG. 1. SIDE ELEVATION.

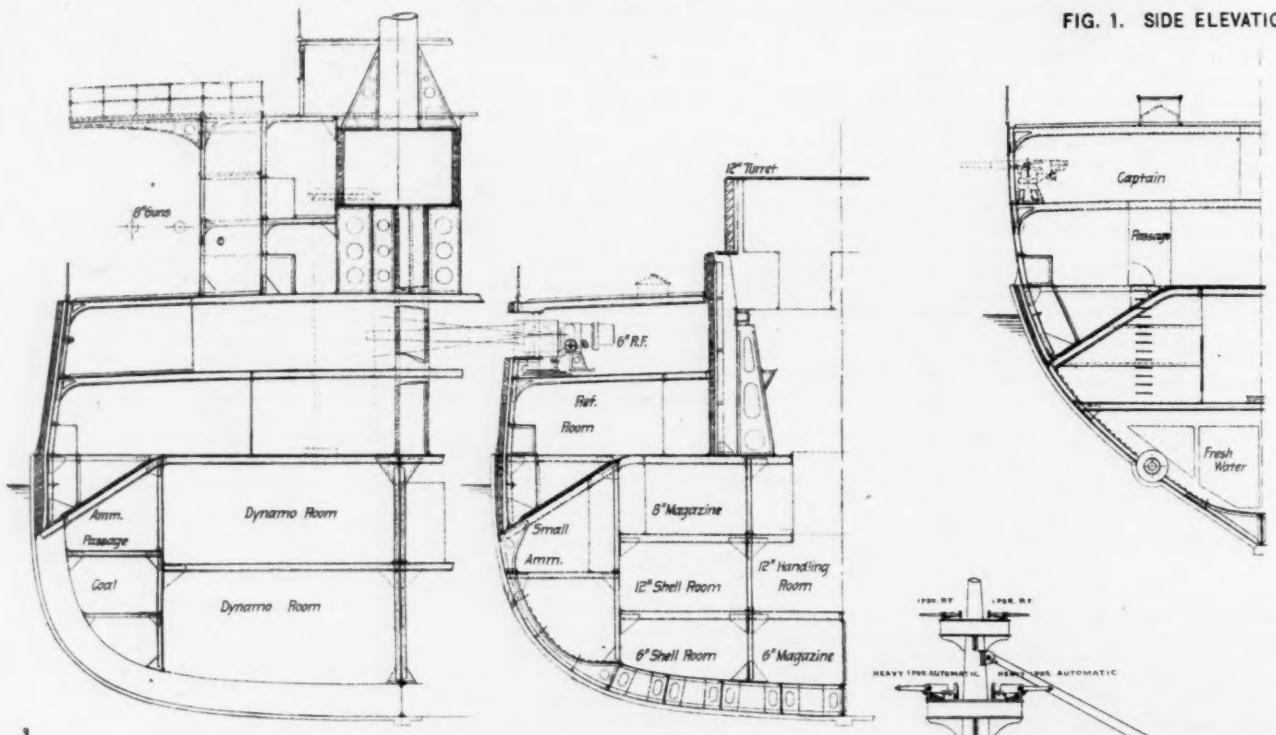


FIG. 3. TRANSVERSE SECTIONS THROUGH CONNING TOWER AND FORWARD 12-IN. TURRET.

FIG. 7. TRANSVERSE SECTION AT FRAME 96 NEAR STERN.

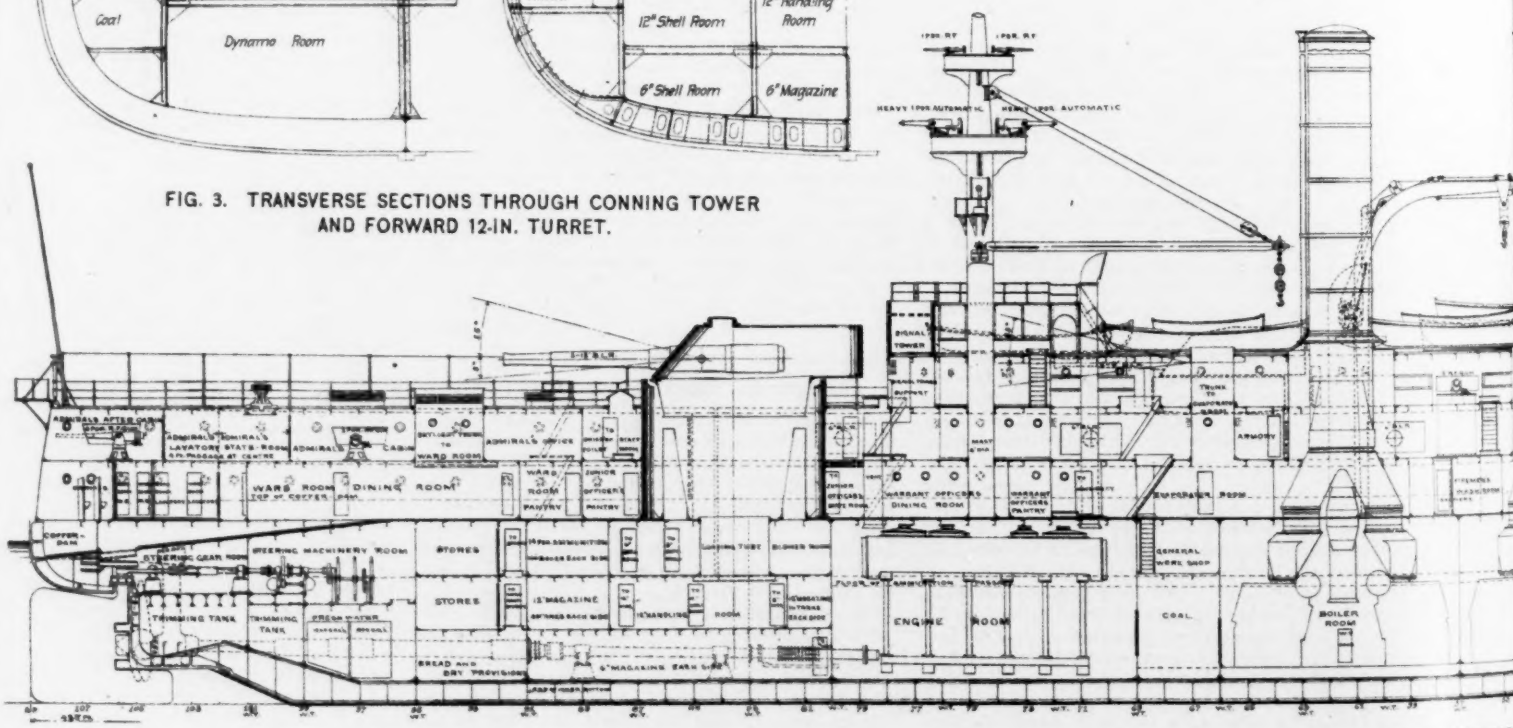
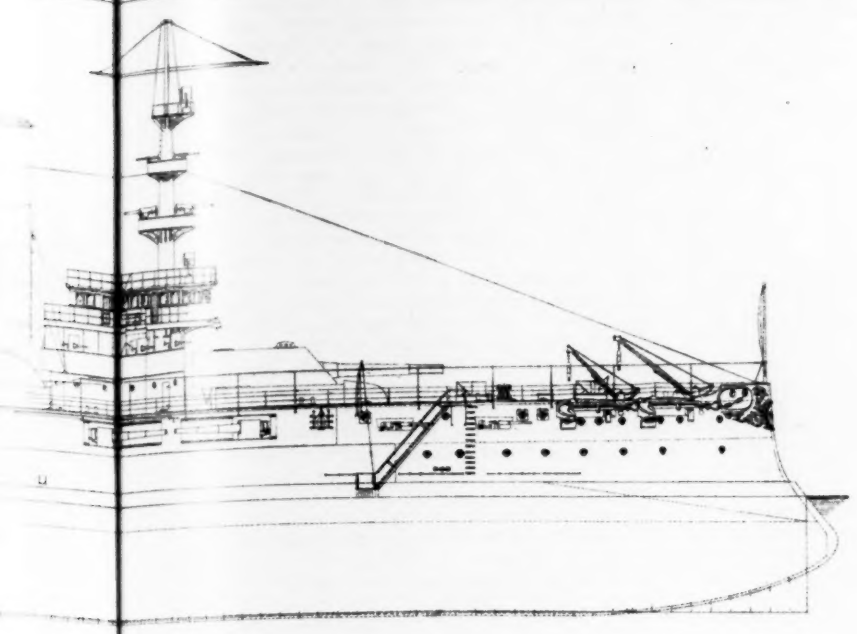


FIG. 2. LONGITUDINA



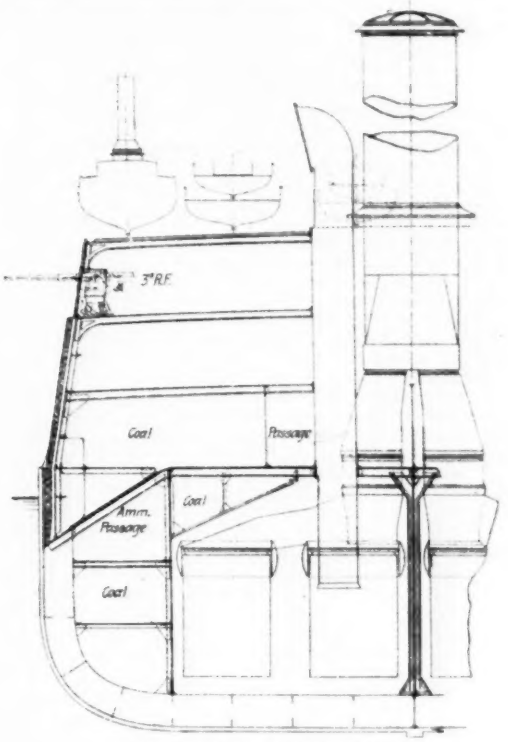


FIG. 5. TRANSVERSE SECTION THROUGH BOILER ROOM.

UNITED STATES BATTLESHIPS

"VIRGINIA" AND "RHODE ISLAND."

Rear Admiral Philip Hichborn,
Chief Constructor
U. S. Navy.

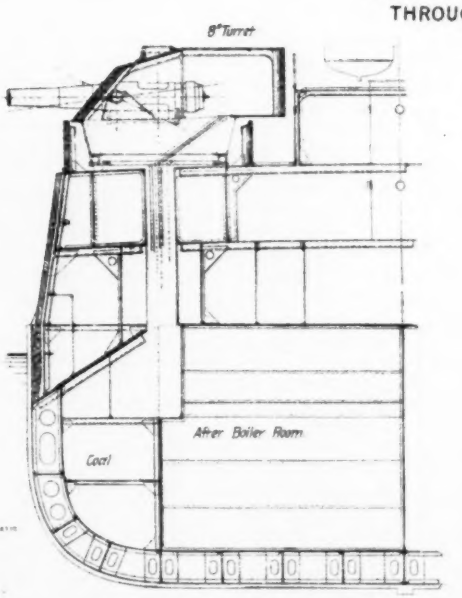


FIG. 4. TRANSVERSE SECTION THROUGH 8-IN. TURRET.

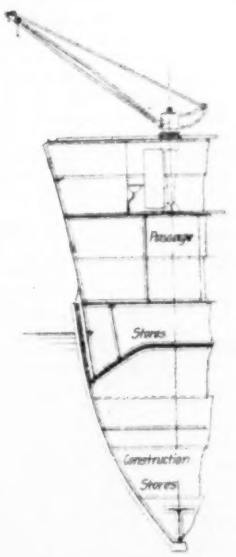
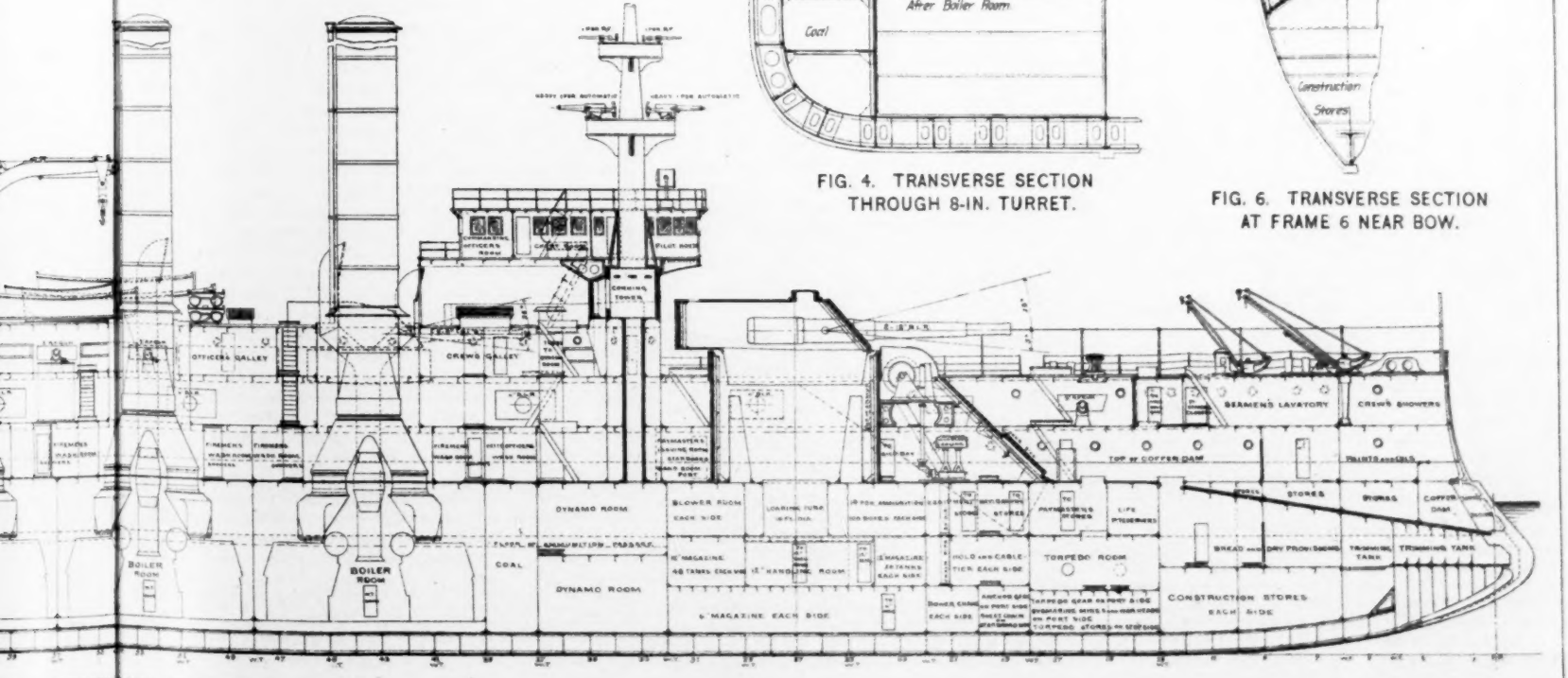


FIG. 6. TRANSVERSE SECTION AT FRAME 6 NEAR BOW.



G. 2. LONGITUDINAL SECTION.

CHAS. HART, LITH., 20 VESEY ST., N. Y.

tute vicissitudes in management, in finance or in politics. That the new corporation's capitalization represents a large amount of "water" is admitted on all hands. It is well known that when each of its component companies was formed the preferred stock was generally intended to represent the actual cost of reproducing the fixed plant of the company, while the common stock represented the hope that the company would earn more than 7% on the cost of its plant. In the new consolidation another generous injection of water appears to have been made, variously estimated at $75,000,000 to $125,000,000.

In other words the new concern, like most other of the so-called trusts, is capitalized on the basis of hoped-for earnings—not on what its plants and properties could be duplicated for. This, in fact, gives the chief motive which has pushed the new consolidation into being. The men who are now in control of the iron and steel industry of the United States could make more money in selling stocks to the public than in carrying on the business for business profits.

Besides this chief motive, the competition existing and threatened between the great rivals was also an important factor. Over a decade ago, it was pointed out that the intensity of competition tends to increase with each decrease in the number of competitors. The course of events in the iron and steel trade has fully proved this. Ever since the organization of the Federal Steel Co., and the other steel combinations, in 1898 and 1899, it has been a sharp race between the different competitors to secure control of mineral lands, coal and coke properties, ships, docks, railways, and finally of finishing plants. Each aimed to be entirely independent of its competitors from the raw material to the finished product. In fact each had to do this or run the risk of being squeezed into a hole where it would have to rely on some competitor either for its supply of raw material or for a market for its finished product.

Such fierce competition, from the very nature of the case, cannot be permanent. It must be terminated either by an agreement between the parties to refrain from competition, or by their actual consolidation (as has now happened), or if it continues long enough the weaker party will be bankrupted and thus removed from the field. In other words, it should be understood that the ultimate consolidation of the steel industry was made inevitable by the previous consolidations which took place in 1898 and 1899.

And now what of the outlook for the new concern? What are its chances of dividends to the holders of its stock? What are to be its relations with its vast army of employees and their officials? Will the millions who buy its products, in one form or other, have to pay higher prices?

To all these questions, the first answer to be made is that very much will depend on the character of the management. One of the most serious evils in the transfer of manufacturing enterprise from private owners to a trust is the tendency to put stock-market speculators in control. There is a vast difference between running a concern with the sole aim of making honest business profits and running it in obedience to the dictates of Wall St. If the new United States Steel Co. patterns its management after the Carnegie Co. it will certainly make large earnings. If on the other hand it imitates the practices of some other of its constituent companies, the iron and steel industry will curse the day of its incorporation.

There is no doubt at all that this new concern is in control of the best and most economical steel manufacturing plants in the world. With good management it can and doubtless will earn great sums of money. But it does sound passing strange to hear financial magnates, whose names have hitherto been synonyms for prudence and conservatism, justifying the capitalization of their huge creation with the following:

> Statements furnished to us by officers of the several companies above named, and of the Carnegie Company, show that the aggregate of the net earnings of all the companies for the calendar year 1900 was amply sufficient to pay dividends on both classes of the new stocks, besides making provision for sinking funds and maintenance of properties. It is expected that by the consummation of the proposed arrangement the necessity of large deductions heretofore made on account of expenditures for improvements will be avoided, the amount of earnings applicable to dividends will be substantially increased and greater stability of investment will be assured, without necessarily increasing the prices of manufactured products

Ordinarily, when a business is to be disposed of the buyer wishes to know what its returns have been in bad years as well as good years. The public which buys the new steel company's securities, however, should understand that its capitalization is based on the earnings of a single highly prosperous year. A simple calculation shows that for the new company to pay its fixed charges, and dividends of 7% on its preferred stock and 3½% on its common stock will require net earnings of no less than $60,000,000. This is more than half as great as the total dividend payments of all the railways of the United States. If the new concern were to be subject to the ordinary laws of trade, its ability to reap such large profits, except in years of phenomenal demand for its products, may well be doubted.

But, it is said, the new consolidation is not subject to the ordinary laws of trade. It controls 60% of the steel beam capacity, nearly 70% of the steel rail capacity, nearly all the steel sheet, tin plate, and steel hoop mills, and a large proportion of the wire producing capacity. The mills which it does not control, moreover, are mostly situated in the East or the far West, or the South; so that in the great central West the new company is now able to dictate prices. Nevertheless, its course is far from being plain sailing. The recent history of the wire trade and the host of active competitors which have sprung up since the American Steel & Wire Co. was formed are a good illustration of what may happen to the new corporation. Prices for steel products which will enable the United States Co. to pay dividends on its common stock will prove undoubtedly attractive to new competitors.

There are many men of enterprise and experience in the steel industries, ready to manage independent enterprises, and plenty of capital to back them. If Mr. Carnegie himself were ten years younger, he might prove a most uncomfortable rival to the concern which has just bought the properties of his company. Even as it is, some of the funds which have been so lavishly poured out by the Morgan syndicate to dispose of the Carnegie Co. as an independent factor, may very likely go toward the construction of independent works with every advantage of location and with some of the talent in control which has been so well trained in the Pittsburg and Cleveland districts during the past dozen years.

We do not believe, therefore, that the United States Steel Corporation means the end of competition in the steel industry. On the other hand we do believe—and economic science tends to show—that it marks a step in the progress toward ultimate monopoly. The new competitors, when they demonstrate their strength, will be bought out and absorbed. Older concerns will be taken in whenever a profit to the promoters can be made by the deal. Thus while the creation of new competitors may protect consumers for a time, it should be understood to be only a temporary remedy, and to be no real answer to the questions: "What shall we do with the trusts?" or its corollary "What will the trusts do with us?"

LETTERS TO THE EDITOR.

Determining the Magnifying Power of Telescopes.]

Sir: This subject, although not particularly interesting to many, becomes at some time or other of more or less importance to engineers. Optical works describe many methods of finding the magnifying power of telescopes, many of which are either lacking in accuracy or are troublesome in application. The writer does not claim to be the originator of the method described below, but he offers it as an aid in overcoming some of the difficulties which have appeared in its application heretofore. The method is described as follows, together with the improvement in the determination of certain points connected with it:

Select some bright sunny day, and after having cleaned the glasses of the telescope and put them in proper position, determine first whether any light from the object glass has been cut off from the eye piece by means of diaphragms or otherwise. This can be ascertained roughly by looking through the object glass at the circle or field of light at the end of the eye piece, in front of which and at a short distance a piece of white paper is held. By moving the eye so that the line of vision will just pass the edge of the brass cell that holds the object glass and be coincident with the corresponding edge of the field of light at the end of the eye piece, any obstacle in the way will be readily observed.

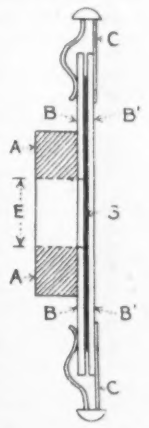
Now, since under ordinary conditions the inner diameter of the brass cell holding the object glass is the true aperture of the telescope, any diaphragm found by the above observation would reduce this aperture. If such an obstruction exists, to determine its magnitude, one writer advises to proceed as follows: After having focused the instrument for very distant objects, turn the object end toward the sky and with the eye drawn somewhat back from the eye-end move the point of a pencil from the outside toward the center of the object glass until it just appears in view; twice the distance from this point to the edge of the brass cell will be the amount to be deducted from what should have been the true aperture, and the remainder will be the actual aperture for the instrument in question. With the telescope in the same position hold a card up close to the end of the eye piece and notice that a small circle of light is thrown upon it; this is the image of the objective opening or aperture of the telescope as reduced by the eye piece and any diaphragm which may have been found in the way by the first observation described.

Let D = working diameter of the object glass or the true aperture of the telescope.
d = the diameter of the small circle of light formed at the focus of the eye piece.
M = magnifying power of the telescope.

Then $M = \frac{D}{d}$.

The chief difficulty in this method lies in the exact measurement of the diameter of the small illuminated circle d, and the working diameter of the object glass D.

To overcome these difficulties the writer has found the following method to be very effective: Instead of trying to find out how much of the aperture of the telescope has been lost by interior diaphragms, etc. After removing the sunshade from the telescope, over the objective and concentric with it, place a metal diaphragm of known diameter D, about one-quarter of an inch less than the inner diameter of the brass cell. This places D in a position to be very accurately measured. Now, with regard to the diameter of the small circle d, arrange an exposure frame at the eye-end of the telescope so that a piece of "Solio" or other sensitized paper can be exposed in the focus of the eye piece. With the instrument turned toward a clear sky expose the paper about one hour; upon removal, a perfectly dark colored dot will be found with sharply defined edges. The diameter of this dot equals d, and by means of a small magnifying glass it can be scaled to the thousandth part of an inch. The measurement of D admits of equal accuracy.



The inclosed illustration shows the exposure frame devised by the writer which answers the purpose very well and does nearly perfect work, although constructed upon somewhat economic lines. A ring of cork, A, fitted by means of the hole E to the eye end of telescope, is glued to a piece of cardboard, B. The thickness of the cork-ring, together with the cardboard, must be sufficient to make the space S come in the exact focus of the ocular. Place the sensitized paper at S, and fasten on the cardboard back, B^1, by means of small brass clips, C, made of bent pins, although those used by the writer were made from McGill Fasteners.

This method used in determining the magnifying power of engineers' transits, if care is taken in measuring the diameters D and d, will not be in error more than 2%.

Yours respectfully, William Nelson,
Laconia, N. H., Jan. 23, 1901. Assoc. M. Am. Soc. C. E.

The Desirability of Abandoning Sand Tests of Cement.

Sir: There has recently been considerable discussion on the relative importance of neat and sand tests of cement. In the opinion of the writer, cement testing can be divided into two classes, those which conform to a given standard and with which the results are to be compared and those in which the cement is placed as nearly as possible under the same conditions as in the work in which it is to be used.

The present sand test is the natural outgrowth of the second class. When cement became an important engineering material it was necessary to determine its quality. Cement was to be used with sand or sand and broken stone and when one knew but little of its physical properties and chemical composition, it was natural to test the cement by mixing it with the material with which it was to be used and observe the results. A difficulty arose here. Each user tested his cement with a different grade of sand, consequently the results of no two testers were comparable and the tester had only his

knowledge and personal observations to direct him. To obviate this difficulty a standard sand of uniform size and composition was used, which in a measure made the results comparable, but departed from the original scheme of making the tests conform to the conditions of use.

In making sand tests the ordinary mixtures are one part cement to one, two or three parts sand. From such a test the only information which can be obtained is the tensile strength. Nothing can be gathered as to the soundness, for pats of mortar will not crack even when the excess of lime is considerable, and the use of sand introduces one more factor to cause lack of uniformity in the result. It is, therefore, necessary to make neat tests of each sample in addition to the sand tests. The only thing which the standard sand can show which will not be shown by the neat test is a variation in the tensile strength due to the degree of fineness to which the cement is ground. The fineness can, however, be determined more quickly and with greater certainty by sifting through an ordinary nest of No. 100 and No. 200 sieves.

At the present time we have gathered sufficient knowledge to enable us to produce a reliable cement and to establish a standard method of testing. This method must be such that a cement which conforms to it will be satisfactory in the work. In testing a cement it is necessary to ascertain if it contains the proper proportions of silica, lime, alumina and iron and also the amount of sulphur trioxide and magnesium oxid. The physical test, if properly conducted, will determine the following points: (1) If the cement has been evenly burned and to the point of vitrification. (2) The degree of fineness to which it is ground. (3) The length of time required for it to set. (4) An excess of lime, and (5) The tensile strength attained after a given period.

The first point is somewhat difficult to ascertain with certainty. The ordinary method of determining it is by weight or still better by specific gravity, as hard burning increases the weight, but this is only an indication for the weight of the material of which the cement is composed may vary irrespective of the length of time and temperature at which it is burned. The fineness is determined with ease and certainty by sifting. All material caught on a No. 200 sieve may be considered as inert matter, for it has no cohesive strength. The time of set is ordinarily determined by use of weighted wires, but the tensile strength at the end of 24 hours is of little value, except as it indicates the degree of set attained. An excess of lime or of lime and magnesia can be determined by neat pats; if the proportion of lime to silica is so large that there is 5% more lime than will combine with the silica, the pats, when left covered, will show fine cracks radiating from near the center of the pat. If the excess of lime is slight or if sulphate of lime has been used to give the cement a high tensile strength for the early tests, the pats when boiled will crack, warp and sometimes crumble away; the usual time of boiling is three hours after a pat is 24 hours old.

The tensile strength is affected by a great variety of causes, such as the temperature method of mixing and breaking. These variations can only be reduced to a minimum by great care on the part of the tester and it is only when those variations are practically eliminated that the correct conclusions can be drawn by comparison of the tensile strength with the four preceding results.

Greater attention should be given to the relation between the tensile strength at the end of seven days and that at the end of 28 days. Specifications ordinarily call for a certain strength at the end of seven days and another for 28 days, the cement may then give a tensile strength in seven days greater than what is required for 28 days and show little increase or even a decrease at the end of 28 days. Such a cement is near its point of greatest strength or has already reached it and begun to decline and is not fit for any purpose. Specifications should give the minimum tensile strength at the end of seven days and the percentage of increase of the 28-day test above the actual breaking strength at the end of seven days, this increase ought to be about 15%.

After careful consideration and considerable experience in testing cement it seems to the writer that the time has come when we can dispense with the standard sand test without losing any information concerning the cement. In very important works and those in which unusual material is to be used with cement, in addition to the regular test, a test should be made to conform as nearly as possible to the conditions under which the cement is to be used.

Respectfully,

Pitson J. Cleaver, Jun. Am. Soc. C. E.,
In Charge of Cement Testing at U. S. Navy Yard, New York.

Brooklyn, N. Y., Feb. 12, 1901.

Rapid Earthwork Calculation.

Sir: In Engineering News of Dec. 13, 1900, Mr. H. P. Gillette publishes a correction formula to be used in computation of earthwork by the mean end areas method.

$$V' = V - D\,(B - b)\,L.$$

V′ = practically correct volume in cubic yards.
V = volume by mean end areas method.
B = the larger end area in sq. ft. of a truncated pyramid.
b = the smaller end area in sq. ft. of a truncated pyramid.
L = length in ft. of the solid.
D = a coefficient depending on ratio $\frac{B}{b}$.

This formula is certainly very ingeniously derived and is correct for the cases for which it was derived, viz.: pyramids and frustums of the same. For practical use, however, it appears to the writer to have little or no advantage over the ordinary prismoidal correction formula, and to have some positive disadvantages.

In the first place, while correct for pyramids and frustums, Mr. Gillette proceeds to apply his formula to other solids than these. The solid cut off from the whole prismoid by a vertical plane through the edge of the roadbed is not a frustum unless the lateral edges prolonged intersect at a common point. This happens to be the case in two of the illustrations used in Gillette's article. Those sections are assumed ones, as shown by the dimensions being given to exact feet and by the convenient forms of sections at stations 0, 3, 4, 5, 7. It would seldom be found true in the field that the necessary condition mentioned above is exactly complied with. Indeed, it will sometimes be true that two of the lateral edges will intersect the third, if at all, beyond opposite ends of the solid. This inconsistency is met in other than five-level cross-sections like those shown in the article. The answer to this objection would probably be that the comparisons exhibited show that the method is near enough to absolute accuracy for any purpose, and perhaps this would be true if a large number of comparisons had been made and if it were not for the next objection.

The formula indicates that the correction is to be subtracted every time. This is always correct when applied to a true frustum, but when applied to a solid resembling a frustum, but having one or more lateral faces warped, it is not necessarily or always true. The prismoidal formula does apply to such a solid, hence a correction formula derived, like the common one given below, by comparing the mean end areas formula with the prismoidal formula, applies to such a solid and the algebraic sign of the correction is taken care of by the signs of the factors in the formula.

In addition, then, to computing the correction by the new formula, one must know the old formula and apply it so far as to determine the sign of the result. Such a method is certainly not ideal, but could be tolerated were it not for the next objection.

The new method cannot be recommended as a time-saver. The ordinary prismoidal correction formula for three-level work is $C = \frac{L}{12 \times 27}(c_0 - c_1)(D_0 - D_1)$. C = correction in cu. yds. to be subtracted from result by mean end areas method. L = length in ft. of the solid. c = center height in ft. from surface to roadbed. D = horizontal distance in ft. between slope stakes. Subscripts distinguish between cross-sections at different stations.

The same formula suffices for five-level and irregular sections because it can be applied to a triangular prismoid or to two of them having a common vertical lateral face, by calling c the vertical dimension of an end section and D the horizontal width of the section or of the two sections having a common vertical dimension.

For three-level work one application of the formula is sufficient; for five-level, two applications.

By the new method, two applications would be necessary for three-level work, unless in the two triangular prismoids needing correction the ratios $\frac{B}{b}$ should be equal, thus requiring the same coefficient D for both. As the majority of work is three-level, there is here an important disadvantage.

Again, there is a loss of time in computing areas, since to use the new method the end sections must be subdivided in a particular way and the partial areas computed for use in the formula, and such subdivision is not the simplest possible one for computing the area of the whole section. Partial areas are not used in the ordinary correction formula, but dimensions instead. These dimensions are taken by mental addition and subtraction from the cross-section notes.

More important than these facts is the fact that not only the mean end areas formula, but also the ordinary correction formula both readily admit of solution by tables and diagrams and such have been prepared in abundance not only for three-level work, but also for any form of cross-sections. To use these, no computation of areas is necessary, the arguments being dimensions of the cross-sections.

The writer does not intend to discuss the necessity of applying any correction to the result by mean areas, but only contends that if it is worth while to apply one it is worth while to apply the correct one, especially when it is also the easiest to apply.

Yours truly,

W. H. Boughton.

Granville, O., Feb. 9, 1901.

(Proof of the above criticism was submitted to Mr. Gillette and we append his reply as follows.—Ed.)

Sir: In answer to Mr. Boughton's criticisms I would say that the cross-sections shown in the article criticised were, as stated, taken from "The Engineer's Field Book" by Cross, and were selected because they are hypothetical and illustrate extremes greater than are common in practice. As to Mr. Boughton's criticism of the accuracy of my formula, I have merely to refer to the table of results at the end of the article in discussion. I was remiss in not calling attention to the fact that the frustums shown in the diagrams used are not in every case frustums of true pyramids; but the approximation is ordinarily so close that the results justify the use of my formula, as conceded by Mr. Boughton.

As to the criticism that the correction to be applied to my formula should not always have a minus sign, where one of the faces is a warped surface, I can only say that practically the results are not affected by an occasional warped face, and furthermore Mr. Boughton is in error when he states that the prismoid formula under similar conditions is exact. This I pointed out in my article and referred to Henck's "Field Book," p. 110, for a demonstration of the statement. In certain hypothetical cases the prismoid formula is extremely inaccurate, but Prof. Johnson has proved in a masterly manner that no other formula or method is any more accurate than the prismoid formula (see p. 435, 11th ed., Johnson's "Surveying"). Finally and most important of all, Mr. Boughton criticises my formula as a time saver. The best answer to his criticism I leave the reader to make, as I have done, by an actual test extending over a mile or more of line. I have been conservative in my claims for the formula used on five or more level sections, for often 20 or 30 cross-sections occur, requiring no tabular correction whatsoever, which mere inspection with the aid of my table makes evident; whereas a man using the prismoid formula would go through all the work involved without ever knowing that the simple mean ends formula would have been practically as exact.

The advantage of my formula as a time saver is concededly much less for three-level section work than where more sections are taken, unless the sections must be plotted, in which case it still possess a great advantage in that midsections need not be plotted by my method.

This leads to a discussion of the desirability of plotting cross-sections. I should judge from Mr. Boughton's statement that three-level sections are ordinarily used, that his experience has been confined largely to railroad work in a comparatively level country.

In certain state and city work all sections must be plotted and entered in record books placed on file. In all cases where more than five elevations are involved in each cross-section, the work must be plotted to avoid confusion, and this occurs in all road work where ditches are to be excavated, and in street work where the crown is not obtained by a straight line from centre to curb. The same may be said of reservoir or any extended excavation work.

Engineers are prone to condemn without qualification a formula or method that fails to satisfy the conditions imposed in their own narrow field of work, without considering the fact that other classes of work exist to which it may be applied with accuracy and with speed.

As for the time consumed in calculating areas which, as I have indicated, must often be done anyway, I may add that it is the least of the engineer's troubles; for with a small table, properly prepared, he can ascertain the area of the quadrilaterals or triangles as fast as an assistant can call off the dimensions.

Mr. Boughton may know of the existence of tables "prepared for any form of cross-section" whereby plotting is unnecessary, rapidity in use assured and accuracy equal to the prismoid formula attained. Personally, while familiar with most of the tables published, I know of none such.

In conclusion I would say that I seldom use my own correction formula, for, as stated in my article, I prefer to take sections according to my rule so close together that the mean ends formula may be applied without appreciable error. I have no more patience than Mr. Boughton with any method that is complex or tedious in its application, and I thank him and others who have written to Engineering News for bringing out the fact that where only three elevations exist in a section, and where they need not be plotted, there exists a formula that is better than mine.

Yours truly,

H. P. Gillette.

Rochester, N. Y., Feb. 20, 1901.

ENGROSSED RESOLUTIONS have been sent by both the American Society of Civil Engineers and the American Society of Mechanical Engineers to the societies who entertained them so royally during their trips to Paris and Europe during last summer. The resolutions have been engrossed in colors on parchment and the work is elaborate and beautiful. Half-tone reproductions of the same will appear in the Transactions of the respective societies. The thanks of the American Society of Civil Engineers have been tendered to the Institution of Civil Engineers of Great Britain, and the resolutions of the American Society of Mechanical Engineers were addressed to the Institution of Civil Engineers and the Institution of Mechanical Engineers of Great Britain, to the Société des Ingénieurs Civils de France, and to Messrs. Ludwig Loewe & Co., and Herr F. Loewe, of Berlin, Germany.

DIFFICULT EARTHWORK CONSTRUCTION ON THE COPPER RANGE R. R.

In our issue of May 31, 1900, we described and illustrated the construction of the Copper Range R. R., a new road built to open up copper mining properties in northern Michigan. A paper on the same subject, written by Mr. C. C. Stowell, who was one of the resident engineers, was presented at the recent annual meeting of the Illinois Society of Engineers and Surveyors, and from it we take the following interesting particulars of difficulties encountered in dealing with the peculiar and treacherous character of some of the materials in cuts and embankments.

The road was, by dint of great effort, opened on Dec. 27, 1899, four days ahead of the time limit stipulated in the land grants, the railway company having assumed control of part of the work in October, in order to expedite progress. Under these conditions, there was, of course, much work to be done to properly complete the road:

After connecting the track, attention was given to building the road, for out of 1,020,000 cu. yds. of excavation called for in the contract, approximately only 700,000 cu. yds. had been completed up to Jan. 1, 1900. Steam shovels were put in operation and have been at work this past season, and on Jan. 1, 1901, the work was not complete.

Some perplexing features developed during the work. The clay was what is generally known as joint clay, extremely hard, and at some points approaching shale. A pick hardly makes an impression in it when dry, and it blasts fairly well, but when wet it is full of such disagreeable qualities as one seldom meets. When a cut was completed in this hard material a portion of the slopes, in the most unexpected places, would suddenly slip gracefully and silently down to the track, displacing or covering it. In some of the cuts, pockets of quicksand were encountered and such spots were corduroyed in order to take out the material around them, after which they could be excavated.

Some of the banks placed on side hills, made of the material taken from clay cuts during the winter, probably contained frost and some snow throughout the mass. When the spring rains came, these would with little warning slide from under the track and assume a slope approaching 4 to 1. One of these slides at Bridge No. 4 overturned trees and crossing a narrow ravine slid some 12 or 14 ft. up the opposite side.

At bridge No. 5, the piles for the foundations were driven from 12 ft. to 20 ft. into the soil through very hard material. A culvert was placed under the bridge to allow the bridge to be filled. The excavation for this culvert was so hard that the contractor was paid rock prices for it. Aprons were placed on the bridge to guide the

Failure of an Embankment on the Copper Range R. R.

dirt from the braces to prevent breaking them. When considerable material had been deposited along the sides, the ground under the fill seemed to compress, and carried the piles under the batter posts gradually down some 10 ins. As the filling progressed and the middle became filled, the whole central portion of the bridge settled about 1 ft. In another bridge, one pile bent was carried down 26 ins. during the process of filling, while those next to it were only slightly disturbed. Immediately adjoining this clay district was one of fine sand, with short sharp cuts and fills. One of these fills was approximately 120 ft. long and 30 ft. deep. The entire watershed tributary to this ravine above the fill was but a few hundred square yards. As there was earth to spare, the ravine was filled on the upper side nearly to a level with the track. There was no other material than the fine sand in the fill, and so far as could be learned by surface examination nothing but sand underneath it. One morning, soon after the opening of spring, the section men noticed that the track was out of line on this fill and stopped to reline it; but before they had taken their car from the track, the bank suddenly seemed to change to a liquid and literally flowed from under the track and went with a rush down the ravine, sweeping trees before it and leaving a clear path behind for some 500 ft. The accompanying view shows the condition while the temporary bridge was building.

The remaining sand in the fill behaved like quicksand, and logs 20 ft. long were placed close together on the bottom and a sill for a trestle bent put on them to support stringers from cribbing at each side of the ravine.

AUTOMATIC DUMPING BUCKET.

The accompanying illustration represents a new form of bucket for handling coal, ore, gravel, etc. which is designed to automatically dump its load. The bail is slotted in such a manner that it continues to move downward after the bucket has come to rest on top of the pile of coal, etc. This movement disengages the side latch on the bail from the catch on the bucket, and the weight of the load tilts the bucket so that its contents are

Automatic Dumping Bucket.

discharged. As the empty bucket is hoisted clear of its bearing, it rights itself and is automatically locked ready for refilling. When the bucket is standing on its bottom while being filled, a small latch behind the bail is thrown over so as to guide the bail, and prevent the bucket from dumping when the hoisting begins. When the full bucket is being lifted, after the lock has engaged, this small latch is thrown back by one of the shoveling gang so as to permit the bucket to dump when it comes to a bearing on the coal pile, etc. The bucket can also be dumped by hand when required. Several of these buckets are in use. They are made by the Cornell Machine Co., of Chicago, to whom we are indebted for the above information.

BROOKLYN TOWER FOUNDATION, THIRD EAST RIVER BRIDGE.

An ordinance authorizing the construction of a third bridge across the East River, between Manhattan and Brooklyn, New York city, was passed by the Municipal Assembly on Dec. 30, 1899, and was signed by the Mayor on Jan. 8, 1900. This bridge, according to a resolution adopted by the Board of Public Improvements on Dec. 6, 1899, was to run from a point on Canal St., in Manhattan, between Forsyth and Chrystie streets, to a point in Brooklyn between the foot of Adams and the foot of Washington streets. With its approaches the structure was to have a total length of 9,330 ft. Shortly after the work was decided upon by the Municipal Assembly, the Bureau of Estimate and Apportionment authorized an issue of bonds amounting to $1,000,000, with which to begin work. The necessary engineering studies were begun at once, and have reached the point where bids for the construction of the first tower foundation are to be received on March 11, 1901. The new bridge is of the suspension type, and its principal dimensions are as follows:

Total length between terminals	9,335	ft.
Length of center span	1,495	"
Length of shore spans, each	850	"
Width over all	120	"
Height of towers to cable center	327	"
Clear height above water at center	135	"
Number of cables	4	
Diameter of cables (approximate)	19	ins.

Capacity: 4 trolley tracks; 2 elevated tracks; one 36-ft. roadway; 2 sidewalks.

The Brooklyn tower foundation will consist of a single masonry pier resting on a timber caisson sunk to or into solid bed rock by the plenum-pneumatic process, and filled with concrete. Fig. 1 shows a plan and elevations of the foundation. By referring to the description of the Brooklyn tower foundations for the New East River Bridge, published in Engineering News of May 27, 1897, it will be noted that the Third Bridge has a single caisson foundation, while the older bridge has a double caisson foundations, each caisson carrying four legs of the eight-leg tower. This difference in plan, of course, makes the caisson of the Third Bridge of considerably larger dimensions than those of the older bridge, which were each 63 × 79 ft. The comparative areas of the two foundations are as follows: New East River Bridge, 9,954 sq. ft.; Third East River Bridge, 11,232 sq. ft. The Brooklyn tower caisson of the present New York and Brooklyn Bridge is 168 × 102 ft., giving a superficial area of foundation bed of 17,136 sq. ft. The main dimensions of the foundations for the Third Bridge are given in Fig. 1. For the purpose of the present description the foundation will be divided into, (1) the caisson and cofferdam work and (2) the masonry work, and the text of the specifications will be followed wherever it is possible.

CAISSON AND COFFERDAM.

CAISSON.—The caisson will be 78 ft. by 144 ft. in plan and 56 ft. in height, or so that when sunk in its place its top will be about 40 ft. below mean high water. It shall be built of good, sound long-leafed Southern pine and oak. In general the construction of the caisson shall be as follows: The lower edge of the outside walls shall consist of a 12-in. × 22-in. timber with one edge chamfered 6 ins. × 8 ins.; the lower face of this timber will be reinforced by a 3-in. × 14-in. oak plank. On top of the 12-in. × 22-in. timber will be laid a course of 6-in. × 24-in. timber, and above this course will come the regular outside wall construction of 12-in. × 12-in. laid horizontally, breaking joints at least 6 ft. An inside wall of 12-in. × 12-in. timber set vertically will extend from the 6-in. × 24-in. timber up into the roof, and every other timber of this wall shall continue to a height of 22 ft., and every sixth timber with halved joints shall extend to the top of the caisson. The 12-in. × 22-in. edge timber shall be fastened to the walls of caisson with 1-in. screw bolts, staggered and spaced 3 ft. c. to c., extending to the top of the second course of 12-in. × 12-in. outside wall timber.

All outside wall timbers to the launching height, 27 ft. 6 ins., above lower edge, shall be drift bolted with 1-in. × 30-in. drift bolts, started in each course, staggered and spaced 3 ft. c. to c. From this point to top of caisson all horizontal wall timbers shall have 1-in. × 30-in. drift bolts started in each course, staggered and spaced 4 ft. c. to c. The pitch of the drift bolts in each course shall be varied with the courses below so as to secure an equal distribution of drift bolts throughout the walls. The vertical wall timbers shall be secured to the outside wall timbers with 1-in. × 20-in. drift bolts spaced 24 ins. c. to c.

The ends of the 22-ft. timbers, the halved joints of the vertical timbers extending to the top of the caisson and the intersection of vertical timbers with the horizontal crib timbers, are to be fastened with 1-in. screw bolts. The vertical corner timber shall be fastened in a similar manner to the outside wall timbers with 1-in. × 20-in. drift bolts spaced 12 ins. c. to c., and the halved joints fastened with 1-in. screw bolts. The lower ends of all vertical wall timbers at the cutting edge are to be halved for 18 ins. to receive 9-in. × 18-in. housing timber, which shall be framed into knee braces and bolted to outside wall timber with one 1-in. screw bolt.

The outside sheathing of these walls will be two courses of 3-in. × 12-in. T. and G. sheathing fastened with ⅛-in. × 7-in. wrought-iron boat spikes staggered 9 ins. c. to c., the first course to be laid diagonally and the second or outside course vertically; all joints to be broken at least 6 ft.

The cutting edge will be protected by an 11-in. × 24-in. × ½-in. angle plate fastened to the bottom and sides of the walls with 7-16-in. × 12-in. wrought-iron spikes with countersunk heads, staggered and spaced 18 ins. c. to c.

The corners of caisson shall be protected with ⅝-in. × 39-in. steel plate for 20 ft. above lower edge, and to top with ¼-in. × 39-in. steel plate fastened with ⅝-in. × 6-in. wrought-iron boat spikes.

The working chamber will be divided by two longitudinal bulkheads and the walls of chamber will be braced to the roof and stiffened with diagonal knees, auxiliary bulkheads and transverse horizontal struts. The longitudinal bulkheads shall be constructed with a depth of 6 ft. 9 ins. from sheathing of roof, and with two walls of 12-in. × 12-in. timber, drift bolted as described for outside walls of caisson below launching height, sheathed with 3-in. × 12-in. diagonal sheathing on each side of bulkhead, fastened with ⅝-in. × 7-in. wrought-iron boat spikes, staggered 12 ins. c. to c. The bottom and top courses of the bulkheads shall be framed into the walls of caisson with halved and dovetailed joints, and drift bolted to the same. All intermediate joints of the top and

bottom courses shall be halved, and the several timbers of these courses shall be fastened together in a horizontal plane with 1-in. screw bolts spaced 3 ft. c. to c. The intermediate courses between shall have plain butt joints and shall be bolted through the sheathing in the same manner with 1-in. screw bolts spaced 3 ft. c. to c., in a horizontal line, in each course of timber. The auxiliary bulkheads shall be located between the longitudinal bulkheads and extending from the end walls of caisson to the first transverse 16-in. × 18-in. horizontal strut. They shall have the same depth as longitudinal bulkheads, and be built up with one wall of 12-in. × 12-in. timber, drift bolted in the same manner and framed and screw bolted in their upper courses, as described for the longitudinal bulkheads. The ends of both longitudinal bulkheads and auxiliary bulkheads shall be secured to the walls of the caisson with two 2½-in. rods at each end for the longitudinal bulkheads, and two 1¼-in. rods for the auxiliary bulkheads.

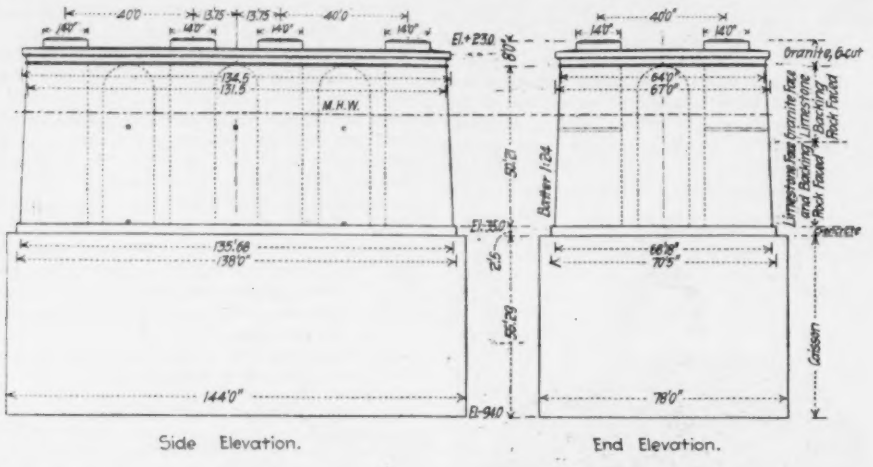


FIG. 1.—PLAN AND ELEVATIONS OF BROOKLYN TOWER FOUNDATIONS; THIRD EAST RIVER BRIDGE.

The knee braces of side walls shall extend from a 12-in. × 12-in. roof sill diagonally to the top of the 6-in. × 24-in. timber in lower edge of wall, except where they occur in the same vertical plane as the transverse 16-in. × 18-in. struts, when they shall be framed in on top of this timber. These knee braces shall be built solid of two 12-in. × 12-in. timbers for the lower course, and two courses of 12-in. × 16-in. to fill the remaining space to the roof and sides of the chamber. The upper ends of these braces shall be cut in against the roof lining and chock blocks, and the lower ends shall cut in against the vertical side-wall timber, the lower course extending through and resting on the 6-in. × 24-in. edge timber of walls. The ends of the 12-in. × 16-in. shall be drift bolted to the roof and side walls with two 1-in. × 24-in. drift bolts at each end. The chock blocks at the upper ends of the lower courses shall be 9 ins. × 11 ins. of oak, and drift bolted to the roof with seven 1-in. × 20-in. drift bolts; and the knees shall also be secured with two 1½-in. rods to each knee, except at corners, where one 1¾-in. rod will be used, passing from the 12-in. × 12-in. sill timber through to the outside of walls of the caisson.

Eight lines of transverse struts of 16-in. × 18-in. timber shall extend across from side to side of caisson, and be framed into side walls on top of the 12-in. × 22-in. edge timber, as shown by details of same. These struts shall be supplemented with two 2½-in. rods to each strut, extending from outside to outside of caisson walls, and to have turnbuckles as indicated in details. These transverse struts are to be secured to the roof with vertical posts, braces and rods.

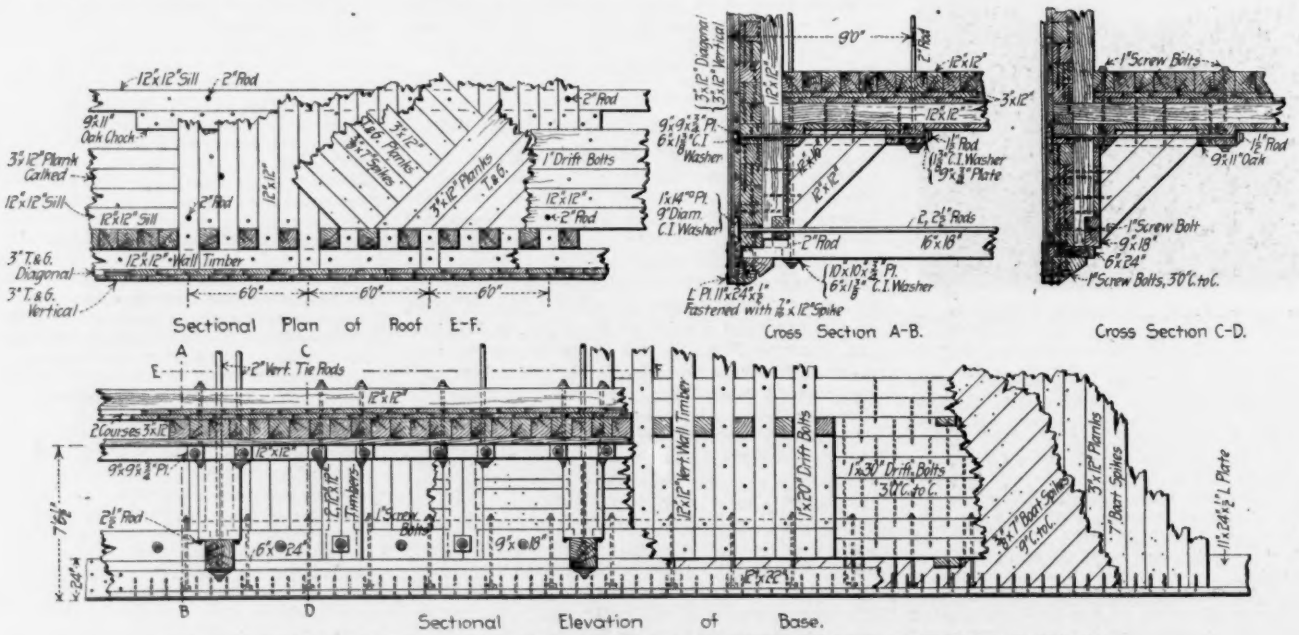


FIG. 2.—DETAILS OF CUTTING EDGE AND WORKING CHAMBER, BROOKLYN TOWER CAISSON; THIRD EAST RIVER BRIDGE.

The roof shall consist of a sill course of 12-in. × 12-in. timber framed and secured to walls, bulkheads and [illegible] braces. On top of this sill course shall be laid a [illegible] of 12-in. × 12-in. timber, which shall be laid as close as possible and secured to sills with 1-in. × 20-in. [illegible] bolts. Every second timber in this course shall [illegible] through the vertical wall timbers of caisson, and every sixth timber shall extend to the outside of caisson [illegible] and be framed into it with a dovetail head; the other timbers will cut off at the inside of the vertical wall timbers. The ends of all timbers will be secured to sills and [illegible] with 1-in. × 20-in. and 1-in. × 30-in. drift bolts, respectively. On top of this course of timber shall be laid [illegible] courses of 3-in. × 12-in. T. and G. diagonal planking, the first course to be laid at an angle of 45° to the transverse timber and spiked to them with ⅝-in. by [illegible] wrought-iron boat spikes, staggered and spaced 18 [illegible] c. to c. The second course of 3-in. planking shall be laid at right angles to the first course, and shall be fastened in a similar manner. On top of this planking shall be laid a course of 12-in. × 12-in. timber laid longitudinally and framed and secured to side walls, as described for the first course of timber. This course will be drift bolted to the planking and timber below with 1-in. × 28-in. drift bolts, spaced 3 ft. c. to c. These two courses of timber and the planking shall be screw bolted together, and to the sill course with 1-in. screw bolts. The ceiling of the roof between sills and the side walls of chamber, between housing timber, sills and knee braces, shall be lined with 3-in. × 12-in. plank, dressed four sides and fastened to 12-in. timber with ⅝-in. × 7-in. wrought-iron boat spikes, staggered 8 ins. c. to c. The spaces in the ceiling between the sills and knee braces shall be filled, solid and flush with the under side of sills, with timber.

The outside seams of horizontal wall timbers, and all chamber seams in vertical wall timber and roof timber, and in roof and wall lining, shall be calked with two threads of cotton, followed with four threads of oakum, the several threads to be thoroughly driven home, and all joints, as far as practicable, to be served with hot pitch. Special care shall be exercised to calk vertical wall timbers at the knee braces and bulkhead ends before these members are put up, and the top course of all bulkheads shall have the upper seams calked before any 12-in. × 12-in. roof timber is put in place. All calked joints shall be chamfered to facilitate proper calking.

The cribbing, from the roof to the launching height, shall be of alternate longitudinal and transverse courses of 12-in. × 12-in. timbers in which all splices shall be halved joints, occurring at intersections. Crib timbers will be framed into outside walls with dovetailed heads, and be bolted to vertical wall timbers, as described above, with 1-in. screw bolts. At all intersections, each course will be drift bolted to the courses below with one 1-in. × 30-in. drift bolt at each intersection.

COFFERDAM.—A cofferdam constructed in three sections shall be attached to the caisson during the progress of the work, to prevent the water of the river from interfering with the construction of the pier. The first section shall have solid walls of 10-in. × 12-in. horizontal timber, breaking joints at least 12 ft., with vertical wall timbers of 12-in. × 18-in. spaced 12 ft. c. to c. The horizontal timber will have 1-in. × 30-in. drift bolts started in each course and spaced 4 ft. c. to c., with one drift bolt on either side of butt joints. The vertical wall timbers

shall be drift bolted to outside walls with 1-in. × 20-in. drift bolts, spaced 24 ins. c. to c., and have long halved splices at rod girts; these splices will be fastened with 1-in. screw bolts either side of joint.

The first two sections of cofferdam shall have the outside joints of wall timber caulked, as described for caisson walls. The second and third sections shall have walls of similar construction, with the exception of the horizontal wall timbers in the third section, which shall be 8 ins. × 12 ins. The rod girts of all sections shall be 12 ins. × 18 ins. The outside sheathing shall be similar in kind and

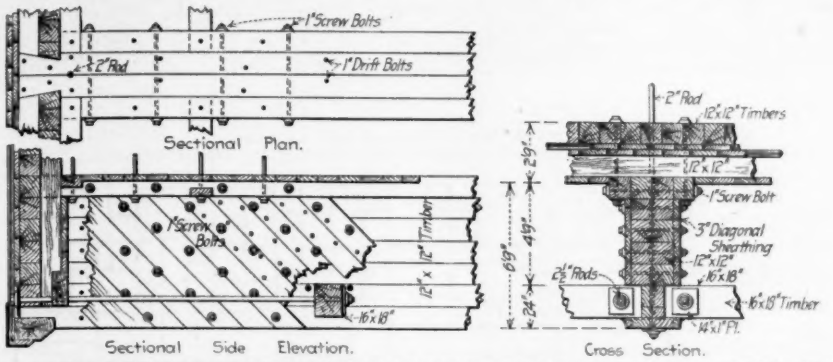


FIG. 3.—DETAILS OF WORKING CHAMBER BULK HEAD, BROOKLYN TOWER CAISSON; THIRD EAST RIVER BRIDGE.

fastening to that specified for the walls of the caisson. The cribbing shall consist of 12-in. × 12-in. timbers in longitudinal and transverse courses, with 3-in. × 12-in. diagonal bracing in each bay of 12 ft.

The first section of cofferdam shall be secured to the caisson by outside wedge clamps made of ¾-in. iron and secured to cofferdam and caisson with ¾-in. × 8-in. lag screws; these clamps shall be placed, two at each corner and opposite each vertical wall timber of cofferdam. The several sections will be secured to each other with 1-in. rods passing through the 12-in. × 18-in. rod girts, using two rods to each corner bay and one rod to each intermediate bay between vertical wall timbers.

SINKING.—The excavation will be carried to bed rock, and as much of this must be removed as is necessary to give a suitable and approximately level bearing for the foundation. The sub-foundation must, if necessary to secure a level bearing, be cut in steps, and must be thoroughly cleaned and washed before any concrete is laid on it.

MASONRY WORK.

The general character of the masonry work is shown by Fig. 5. Generally speaking, all cut stone work is to be laid with ½-in. bed joints and ¼-in. vertical joints; the coping and all exterior facing above mean low water are to be of granite, and the exterior facing below mean low water and the lining of the wells are to be of limestone. A noteworthy feature of the work is the use of an embedded I-beam grillage in the cove course of the pier to resist the action of temperature changes and the side thrust of the tower legs. The location of this grillage is clearly shown by Fig. 5.

As indicated in the opening paragraph the bridge is being built by the city of New York under the supervision of the Department of Bridges, Mr. John L. Shea, Commissioner, and Mr. Samuel Probasco, Chief Engineer. Mr. R. S. Buck, M. Am. Soc. C. E., is Chief Engineer in Charge.

THE QUALITY OF STEEL FOR RAILS.

Among the questions discussed at the International Railway Congress, held at Paris in September, 1900, was that of the proper quality of steel for rails, and notes from some of the reports presented in regard to foreign experience and practice may be of interest.

A report prepared by the late Mr. Bricka (formerly Chief Engineer of the French State Railways), relating to the railways of all countries except those of the United States, showed that the superiority of hard steel over soft steel is now universally admitted, while the improvements in metallurgy enable rails of hard steel of uniform quality to be turned out regularly, thus avoiding the weakness and liability to fracture which were the only former obstacles to their use. The minimum hardness corresponds to a tensile strength of 92,260 lbs., except in special cases where softer steel is adopted for reasons of economy, and many of the French roads use steel of 99,360 lbs. Rails of basic steel may now be made as good as those of acid steel; they are allowed on several railways, and the only failures reported relate to a former period when the manufacture under this process was defective.

No relation can be drawn between the hardness of steel for rails and tires. For both it is desirable to have steel as hard as the processes of manufacture will permit, with due regard to safety in service. As to obtaining homogeneity of metal in heavy rails, the engineers of the Jura-Simplon Ry. (Switzerland) believe that it will be necessary to increase the hardness (by increasing the carbon content) in proportion to the increase in section. On this road heavy rails made by the same process and having the same tensile strength as lighter rails were less homogeneous and showed a more rapid wear. This experience is in accord with general experience in this country. Mr. Bricka, however, considers that the same result may be obtained without changing the composition of the metal, by modifying the form of section and employing more powerful rolling mills, which will enable the rails to be passed through the finishing rolls at a lower temperature.

The length of rails ranges from 26.24 ft. to 39.36 ft., and there is a tendency to go beyond the latter. The Eastern Ry., of France, uses 59-ft. rails in tunnels, and the Paris, Lyons & Mediterranean Ry. laid rails of the same length in open track in 1897, with results which have so far been satisfactory.

As to the wear of rails, statistics from the Eastern Ry. and Western Ry., of France; the Austrian State Rys. and the Kaiser Ferdinand's Northern Ry., of Austria, indicate a wear of about 0.039-in. per 100,000 trains on level sections of the line where the brakes are not applied. On the Northern Ry. of France the wear is about 0.073-in. for the same traffic and conditions. The wear increases very considerably under the action of the brakes, and may be five times as great as the above on parts of the line where brakes are applied on all trains. Rail renewals in tunnels are not due to wear of the head by the traffic, but to a reduction of the entire section due to corrosion. No rule can be laid down as to this, for the length, dampness and ventilation of the tunnels, and the quality of fuel burned by the engines have a more important influence than the quality of the steel or the number of trains. Increased wear of rails near the seashore seems to be very slight in Europe, but it is very rapid in tropical climates.

Rails are not allowed to reach their full limit of wear in main track, but are used for renewals on sections with lighter traffic, or for station tracks, and finally for new track or renewals on lines of light traffic. The wear under traffic is not the only point to be considered in regard to the wear of rails. Apart from occasional defects whose importance is in relation to the quality of the metal, the kinking or bending of the rails (especially at the joints), the wear at splice bars and at bearing surfaces, all tend to make renewals necessary before the full wear of the head has been reached. Very deep heads, therefore, designed to give great wear, do not present the advantages theoretically attributed to them.

The general opinion among railway officers is that the details of manufacture should be left to the makers. Some railways merely prescribe

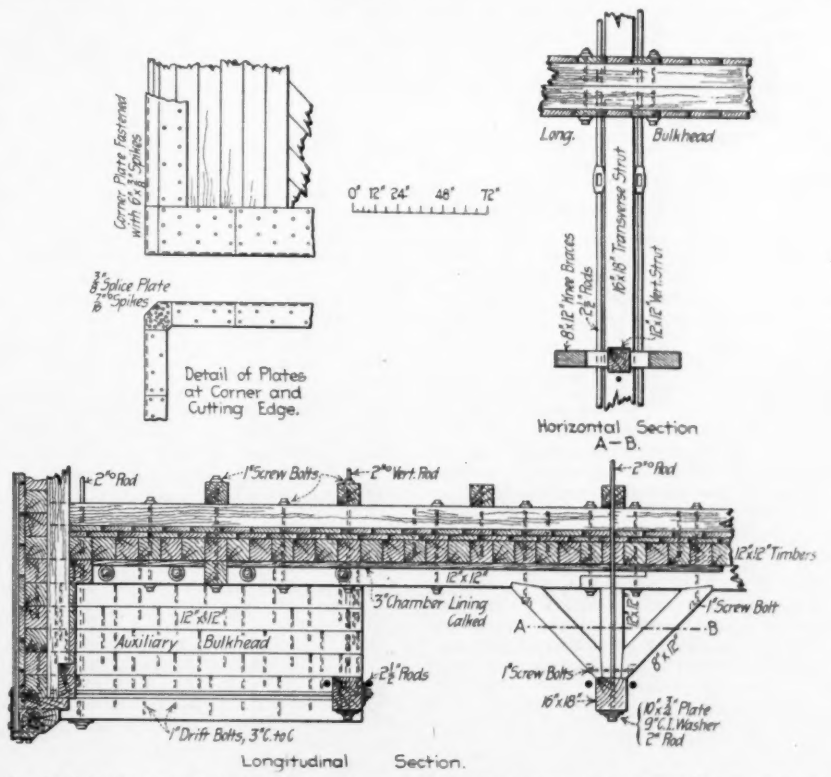


FIG. 4.—AUXILIARY BULKHEAD AND CORNER PLATING DETAILS, BROOKLYN TOWER CAISSON; THIRD EAST RIVER BRIDGE.

drop, tension and compression tests. Others specify the process of manufacture (acid or basic), the chemical composition, the dimensions of the ingots, the style of ingot molds, the length to which the blooms are to be cut, etc. As already noted, there is a tendency to remove restrictions relative to the use of the basic process. Except in Austria, where the Martin process is preferred, the steel is generally made in converters. Another tendency noted is in attaching more importance to requirements and tests relative to the chemical composition of the metal. These generally fix a

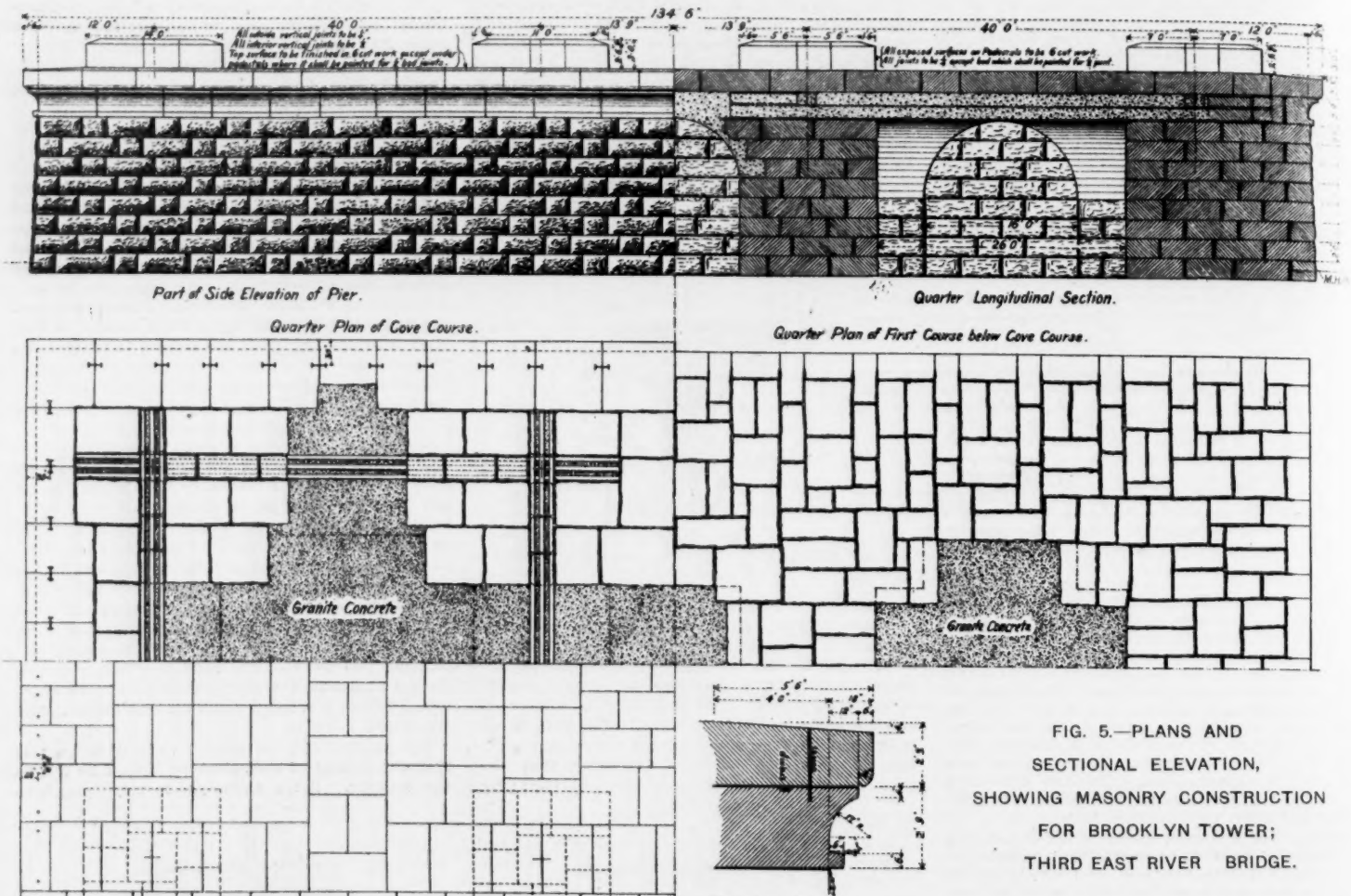

Part of Side Elevation of Pier.
Quarter Longitudinal Section.
Quarter Plan of Cove Course.
Quarter Plan of First Course below Cove Course.
Granite Concrete
Granite Concrete
Quarter Plan of Top Course.
Section of Coping.

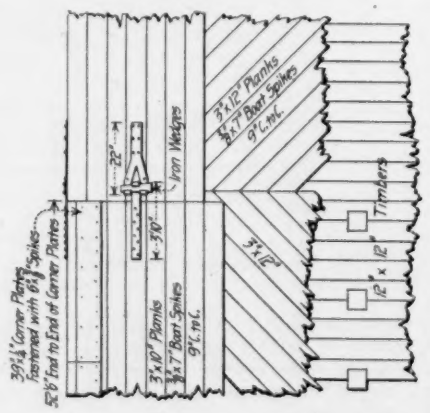
FIG. 5.—PLANS AND SECTIONAL ELEVATION, SHOWING MASONRY CONSTRUCTION FOR BROOKLYN TOWER; THIRD EAST RIVER BRIDGE.

minimum proportion of carbon (0.3 or 0.4%) and a maximum proportion of phosphorus (0.1%). The specifications of the Hungarian State Railways have also a clause relative to the manganese, which must not exceed 0.6% in steel made by the Thomas process.

The utility of clauses prescribing the chemical composition is questioned by some engineers. Prof. Tetmaier, of Zurich, has expressed the opinion that such clauses should be struck out, as long as there is no method determined upon for arriving at any degree of precision in the tests, or for treating the test pieces. Mr. Bricka supported these arguments as far as they relate to the influence of tests in accepting or rejecting a lot of rails on the results of chemical analysis. Engineers experienced in this work know that differences can exist between analyses of the same specimens made by different processes, as well as between analyses of two specimens cut from the same part of the same rail. It is of course true that the analyses furnish valuable information as to the elements affecting the hardness of steel and the homogeneity and uniformity of quality of the metal, provided that they are made in sufficient number by good and uniform processes. Some railways, therefore, now require analyses to be made, but do not make the results a basis for acceptance or rejection of rails.

As to avoiding blow-holes or piping, most railways consider that this is a question for metallurgists. Some, however, state that they have to some extent attained the desired effect by cutting off the upper part of the ingot, by pouring the metal into the bottom of the ingot mold, or by adding a small quantity of aluminum at each pouring. No means has been discovered of ascertaining the existence of blow-holes in the ingot. Microscopical examination of etched surfaces of the ingots has been tried, but several of the French railways and the Jura-Simplon Ry. (Switzerland) state that no conclusive results have been obtained. The Kaiser Ferdinands Northern Ry. (Austria), however, declares that valuable information has been obtained regarding the greater or less homogeneity of the metal. Prof. Tetmaier approves such examinations, and even believes that from similar examinations of rails, the probable strength and life of the rails may be foretold. While not disposed to go as far as this, Mr. Bricka concluded that such examinations play an important part in steel working and rail manufacture, giving information which neither ordinary tests nor chemical analyses can give.

Upon the death of Mr. Bricka the directors of the Congress appointed as his successor Mr. J. W. Post, Division Engineer of the company operating the Netherlands State Railways. His report, supplementing that already abstracted, relates to the investigation as to the wear of rails which were made by the Railway Union. This Union comprises the railways of Germany, Austria, Hungary, Roumania, Poland, Holland and Luxem-



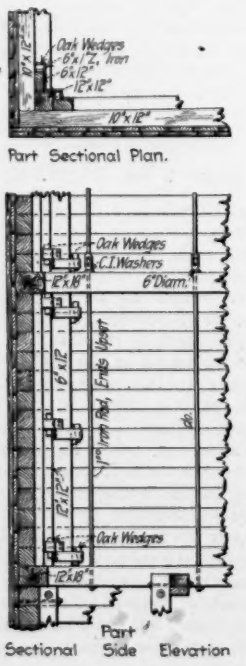


FIG. 6.—DETAILS OF CONNECTIONS BETWEEN COFFERDAM AND CAISSON, BROOKLYN TOWER FOUNDATIONS; THIRD EAST RIVER BRIDGE.

long; with about 54,560 miles of line and 66,960 miles of track. Records have been kept since 1879. One set of statistics is based on 537 places of observation, 656 ft. to 4 miles long, on 31 different roads. These do not take account of the nature of the metal, but give only the renewal of rails and the wear of the rail heads.

In spite of 17 years of observation, the Union has not succeeded in discovering any law governing rail renewals. The report made in 1899 states that the problem is too complex to enable coefficients to be established for the varying grades and curves, especially as the nature of the metal, which exerts a governing influence, was not taken into account. As a broad average (deduced from 186 places of observation, on level and grades, tangents and curves) it is found that about 16 ft. of rail have been replaced per mile per million tons of total traffic. Of this, 9½ ft. were not suitable for relaying, and 0.1 rails were broken. These results are very inconclusive. As an average from the same observations, the loss of weight and section per million tons of traffic are given as follows:

Loss in height	.00364	in.
" " for single track, tangent	.00204	"
" " for double track, tangent	.00216	"
Loss in section	0.007	sq. "
" " for single track, tangent	0.004	" "
" " for double track, tangent	0.004	" "

FIG. 1.—A COMBINATION HAND AND PUSH CAR.
Manufactured by the Imperial Mfg. Co., Jersey City, N. J.

The average loss in height per million tons of traffic was 0.00380-in. for the years 1879-1893, and 0.00388-in. for 1879-1890, indicating that the resistance to wear increases with the age of the rails. The statistics also indicate that the wear, on both double and single track, increases as the radius of curves decreases. The minimum wear was not on the level, but on slight grades of 0.4 to 0.5%. The statistics do not confirm the statement that has been made that with equal tonnage the wear is heavier on single track than on double track. Nor do they show that for double track on slight grades the wear is heavier in ascending than in descending. These observations have been discontinued, as they were troublesome to make and gave only vague results.

Comparative tests from 1882 to 1899 on the Netherlands State Railways, with rails of 66,710 lbs. to 106,450 lbs. per sq. in. breaking load, and eliminating the influence of grades, curves and brakes, have enabled the following conclusions to be drawn:

1. The diminution of weight by wear and rust is nearly the same on double and single track.

2. The reduction in weight corresponding to the first 30,000 trains was 28½% greater on soft rails than on hard rails.

3. The reduction corresponding to the next 65,000 trains was 9½% greater on the hard rails.

4. The reduction per 10,000 trains was greater for the first 30,000 trains than for the following 65,000 trains, even for hard rails.

5. The dimunition of weight corresponding to the first 95,000 trains is practically the same for both hard and soft rails.

Mr. Poulet, Manager of the Southern Railway of France, follows these reports with a paper on the rails of England and the British colonies. The double-headed rail in 30-ft. lengths is found to be most common on English railways, but there is a tendency to increase the length to 36 and 40 ft. The weight varies from 45-lb. flange rails in the colonies to 92-lb. double-headed rails in England. The tensile strength of the steel required varies usually from 40 to 50 tons per sq. in., or more generally 45 tons. Three lines require only 33 to 35 tons. Some companies require an elongation of 15 to 20%.

All the companies reporting use Siemens-Martin and Bessemer steel, made exclusively by the acid process. Some companies prefer to leave the responsibility of the method of manufacture to the railmakers, contenting themselves with guarantees and with an inspection of the work. Others, however, go more into detail. The chemical composition ranges about as follows:

Carbon	0.35 to 0.50%	Phosphorus	0.06 to 0.08%
Silicon	0.06 to 0.15%	Manganese	0.80 to 1.00%
Sulphur	0.06 to 0.08%		

Companies whose specifications are of a very general character content themselves with requiring tests to be made as required, but without describing them. Many others, however, specify the tests to be made, especially for tensile strength (giving the limits of resistance), and stating the length of butt, weight of ram and height of fall for drop tests. Drop tests are commonly required, but great diversity exists as to the above details. A few companies specify chemical analyses, but none require microscopical examination of etched surfaces.

AN IMPROVED TYPE OF HAND CAR.

The hand car shown herewith is noteworthy because of its lightness and adaptability to various kinds of work. It is made in four sizes, ranging in weight from 550 to 700 pounds. The gallows frame and working beam may be quickly removed, adapting the machine for use as a push car, thus eliminating the necessity of hauling an extra car about over the road. The leverage and travel of the handle bars may be adjusted while the car is in motion, permitting a long sweep of the handles when running with heavy loads or up steep grades, and a short sweep of the handles when it is desired to run at high speed. This tends to eliminate the danger of men losing their hold while running at a great speed. In a recent test on the Central R. R. of New Jersey a speed of 20 miles an hour was obtained without any particularly great effort. For the cuts illustrating this article and the information given, we are indebted to Mr. J. R. Vandyck, of 136 Liberty street, New York city, who is placing the car upon the market.

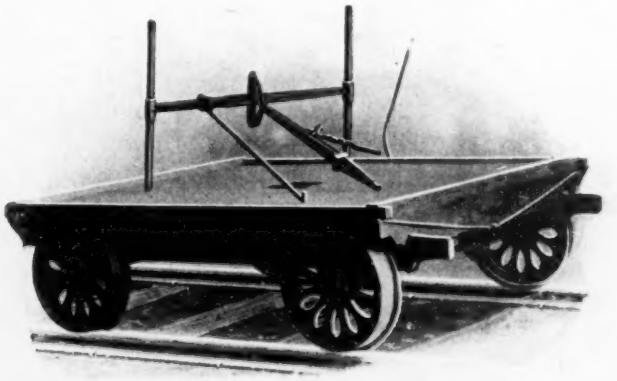


FIG. 2.—COMBINATION CAR WITH GALLOWS REMOVED.

FLYWHEEL EXPLOSIONS.*

By Charles H. Manning, M. Am. Soc. M. E.†

About ten years ago an epidemic of flywheel explosions began, and in the three years, 1892, '93, and '94, it prevailed to the extent of about one large wheel a month, not to mention those under 12 ft. in diameter. These wheels, without exception, were of cast iron and of all sorts of designs and qualities of metal, and most of them went to pieces from overspeed, commonly known as "racing." In the following years, down to the present time, the casualties have been decreasing, and I have not noticed more than one or two since the beginning of this year. Much has been written on the subject, discussing especially the proper design and more particularly the proper bolting of the joints in the rim, but very little has been said on the subject of the material of which the rim of the wheel should be made. Flywheels, as their name implies, are primarily used to regulate the speed of an engine, not the number of revolutions, but the uniformity of speed during any one revolution, storing power while the piston is exerting more than the average power, and restoring it when the piston is delivering less than the average, which, of course, causes a series of fluctuations in the strains thrown on the wheel. With most engines the flywheel combines with its regulating function the office of main driving pulley carrying the main belt, or it may take the form of a large gear wheel. The combination of these several functions and their accompanying strains, subjects this member of the machine to greater variations perhaps than any other part.

The greatest strain, however, and the one that causes the wreck in most cases, is the centrifugal force, principally of the rim itself, which is the part having the greatest linear speed, and this strain increases with the square of the speed. Increasing the cross-section of the rim does not help the strength at all, as the weight, and, therefore, centrifugal force, both increase directly with the cross-section. This shows that for any material there is an exact limit to the safe speed at which the wheel may run. The centrifugal force acting radially in all directions and uniformly, puts the rim in a state of tension, and, therefore, it is the tensile strength of the material used on which the integrity of the wheel depends.

Now as weight is the chief desideratum, it is evident that the material which has the greatest strength for a given weight is the best for a flywheel. I contend that cast iron is the poorest, as far as safety is concerned, of any material used for flywheels, though it is used to-day for at least 95% of the wheels that are made. I remember many years ago several large cast-iron bridges, but I do not believe there is a bridge engineer living who would have the hardihood to put in a cast-iron tension member on any such structure, and the day will come when there will be no cast-iron flywheels, and the sooner the better.

For belt transmission a speed of about 5,000 ft. per minute has been found most suitable, and this has regulated the general run of flywheels to about this rim speed, and at that speed a first-class cast-iron wheel has a fair factor of safety, but the trouble is, all engines are liable to "run away," some much more so than others, and as I before remarked, the explosive force increases as the square of the speed, and it takes but a few seconds to wipe out a factor of safety of from four to six.

For the same weight pine wood has a much greater tensile strength than cast iron, and therefore is much safer for a flywheel, and ten years' experience with many such flywheels has satisfied me that for engines running at a speed of 100 revolutions per minute or less, a properly

*Abstract of a paper read before the American Association for the Advancement of Science.

†Gen. Supt. Amoskeag Mfg. Co., Manchester, N. H.

constructed wood-rimmed flywheel is much the safer. In October, 1891, a cast-iron flywheel 30 ft. in diameter and 110-in. face went to pieces at Manchester, N. H., and a wood-rimmed flywheel of the same dimensions was substituted for it, which is running to-day in as good condition as when new. Some 20 other wheels ranging from 20 to 30 ft. in diameter and from 30 to 120-in. face have been builit and in no case have they given any trouble, though several of them have at times been partly submerged by freshets. Where the speed of the engine runs above 100 revolutions per minute, to keep the rim speed down to 5,000 ft. per minute the diameter of the flywheel cannot exceed 16 ft., which is about as small as it is desirable to make a wood-rimmed flywheel. Below this I have built flywheels with boiler-plate rims, making one of 24 plates ½-in. thick and 30-in. face, which makes a very satisfactory wheel.

In Germany some balance wheels to run at a surface speed of 10,000 ft. per minute and upwards, have been constructed by winding a square steel wire on a cast-iron spool, and the results, as far as I know, have been very satisfactory.

POCKET RECORDER FOR TESTING MATERIALS.

In our issues of June 3, 1897, and May 12, 1898, we illustrated and described a recording extensometer, invented by Mr. Gus. C. Henning, M. Am. Soc. M. E., of the St. Paul Building, New York. This device has been improved since that date by substituting a flat recording frame for the cylinder, and by giving the machine a wider range in practice. The recorder consists essentially of two clamping frames, a system of multiplying levers and a frame for the record paper. This recorder is applied directly to the material under test in the usual form of testing machine, and is arranged to record the stress strain in that material.

Referring to Fig. 1, the two clamping frames F F' are hinged and held together by taper pins, and are provided with adjustable knife edges, passing through spring-cushioned bushings, to permit of their adjustment to the dimensions of the test-piece. These two clamping frames are held the desired distance apart, on centers, by the rods G' and the tubes G, one telescoping into the other. By clamping the lower frame first and then lowering the upper one until the rod and tube abut, the knife edges must bear on the test-piece at points exactly 8 ins. or any other desired distance apart.

The record-paper frame D is mounted on a bracket, which also carries the reducing pulleys P and the guide-bar V. At the bottom of this frame is the rack-bar A^1 geared to the pinion I, which, like the pulleys, is secured to the spindle by friction alone. A string passing around the pulley P and connecting it with some regularly moving part of the test machine, moves the frame back or forward proportionately to the stress applied. The lower clamp carries a bar B, which is the stand for the lever system, and also the tubes R, sliding on the rods R^1. The lever system carrying the adjustable marking pen at its free end, is operated by an adjustable connecting rod N, which transmits any relative displacement between the clamping frames. If this motion is sufficient to cause the lever L^4 to bear against the adjustable nut H, the whole lever system becomes locked and no longer multiplies; but the pen then slides on the rods R' and records the actual relative displacement of the two clamps F F'.

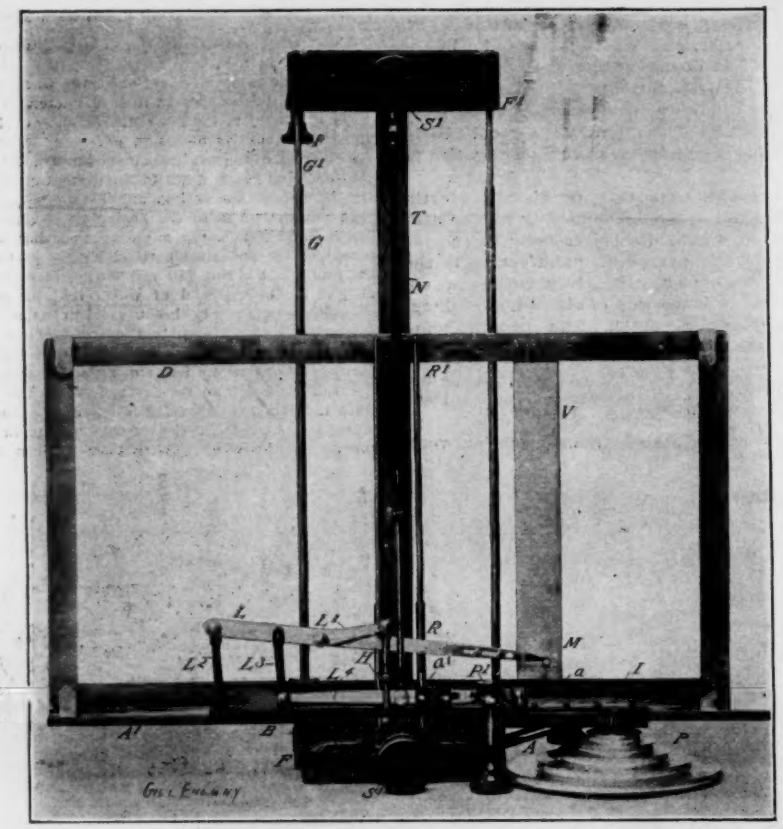


FIG. 1.—VIEW OF POCKET RECORDER FOR TESTING MATERIALS (HALF-SIZE)
Gus. C. Henning, New York City, Inventor.

By additional holes in the levers L_4, L^4 and the bar B, the ratio of record can be changed from 10 to 20, to 25, 40 and 50-fold. As the pen is adjustable, any slight inaccuracies in the position of the connecting holes may be corrected. By the use of a micrometer the recorder can be accurately adjusted to any desired scale of record.

This recorder is applied to a tension test as follows: The clamps and knife edges in both frames are carefully set about the axis of the test-piece, and the record-frame with its paper mounted, with the pen touching the record further to the right than is shown in the cut. A string is then placed around the groove in the pulley P, with one end attached to some part of the testing machine that moves proportionately to the loads applied; and the other end of the string is carried over a guide-pulley, with a screw attachment, and ends in a poise-weight to keep the string stretched. The pen is then set and the recorder is ready for work.

The instrument is set for an 8-in. gage length and records elastic elongation on a ten-fold scale; though for experimental purposes the record may be largely magnified by moving the pins in the lever, arms, etc., as before mentioned. Tests of 2 to 12-in. lengths may also be made by devices provided. For a crushing test, in 8-in. lengths, the side-rods G are taken out; the nut H is then set so that the pen stands 1 in. above its lowest position, and the connecting rod N is shortened as much as possible. The apparatus is then applied as in a tension test.

The two cards, Figs. 2 and 3, are from tension tests made on plate and angle in regular mill practice. Mr. Henning points out that while the card "Fig. 2," shows the yield point at 17,080, the beam of the testing machine located it at "d," or 19,900; or at 30,170 lbs. instead of 35,800 lbs. per sq. in. In the case of Fig. 3, the card shows the yield point at 28,750; while the drop of the beam located it at "d," or 35,800; or, at 40,000 lbs., instead of 50,000 lbs. per sq. in. These cards are selected from a large number as being characteristic and interesting to those familiar with the testing of materials. They come from one of the largest railways in the United States, and were made to check and accompany tests of full-size members built from the same material. It is the practice of this railway to have one extra member made for each type to be tested; and then to select one at random for test to destruction.

Card, Fig. 4, shows the results of crushing tests; and all of them were obtained from one test-piece of cast iron subjected to alternate tensile and crushing loads. A double repetition of this most difficult and interesting test is here recorded; the full lines showing the crushing tests and the broken lines the tensile tests. The crushing load applied in test "A" was 14,850 lbs. per sq. in., followed by a tensile load of 15,325 lbs. In test "C" the crushing load was the same, and the tensile load was 16,000 lbs.; 32,000 lbs. per sq. in. caused rupture.

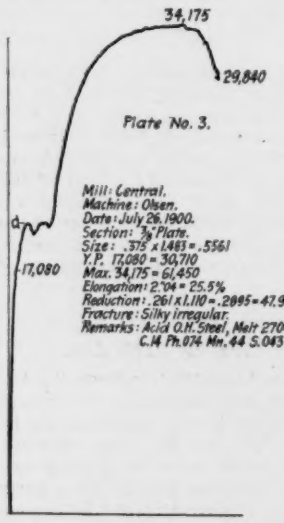


Fig. 2.

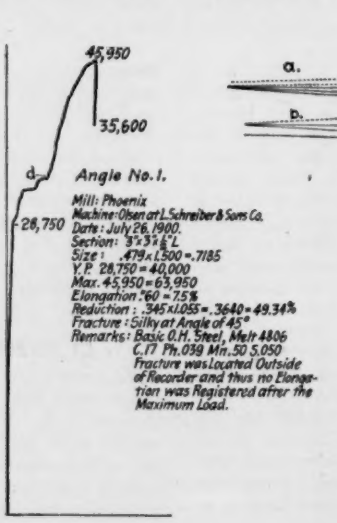

45,950
35,600
d
28,750
Angle No. 1.
Mill: Phoenix
Machine: Olsen at L. Schreiber & Sons Co.
Date: July 26, 1900.
Section: 3"x3"x⅜" L
Size: .479 x 1.500 = .7185
Y.P. 28,750 = 40,000
Max. 45,950 = 63,950
Elongation: .60 = 7.5%
Reduction: .345 x 1.055 = .3640 = 49.34%
Fracture: Silky at Angle of 45°
Remarks: Basic O.H. Steel, Melt 4806
C.17 Ph.039 Mn.50 S.050
Fracture was Located Outside of Recorder and thus no Elongation was Registered after the Maximum Load.

Fig. 3.

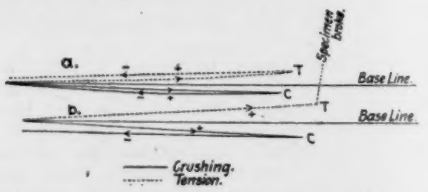


Fig. 4.

Eng. News.

FIGS. 2, 3 AND 4.—TYPICAL TEST RECORDS TAKEN BY POCKET RECORDER (HALF-SIZE).